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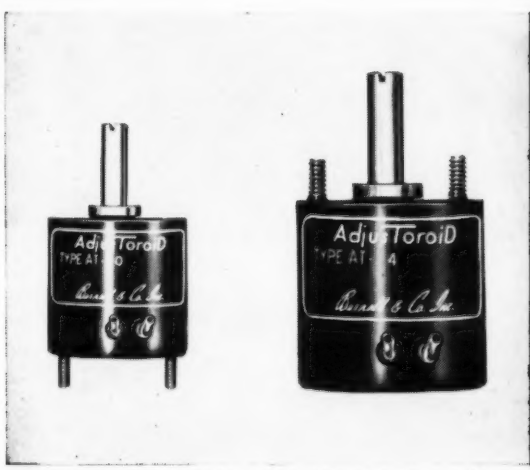
Military Systems Design

FORMERLY MILITARY AUTOMATION



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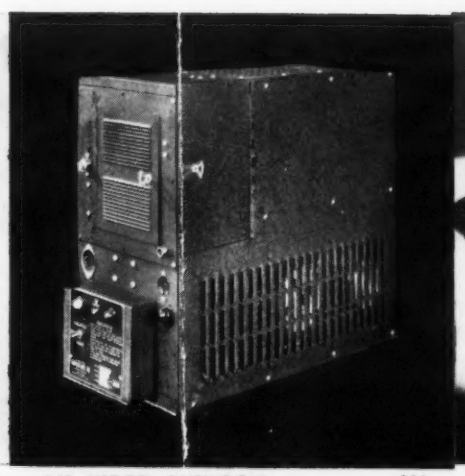

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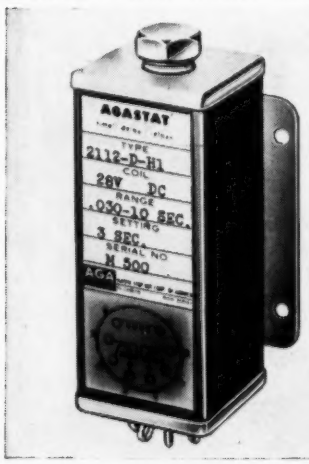

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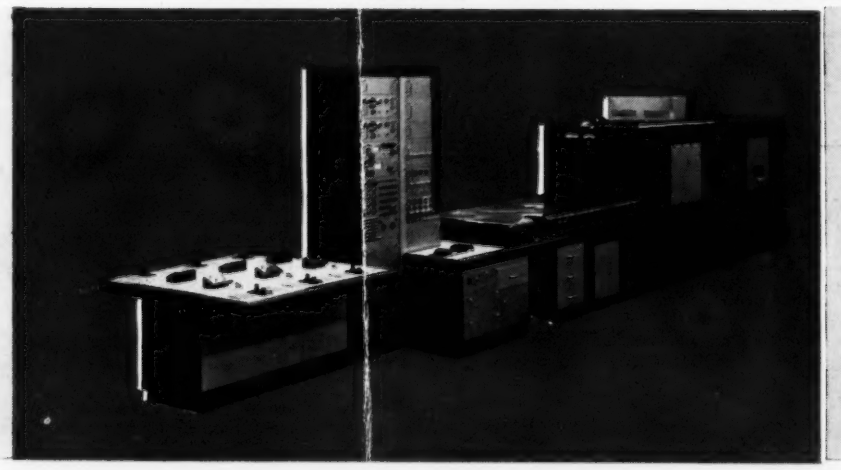

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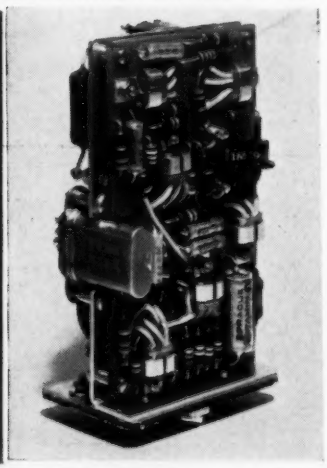

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1958

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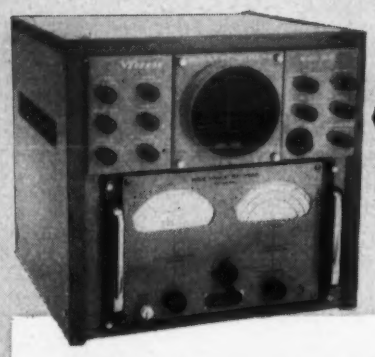

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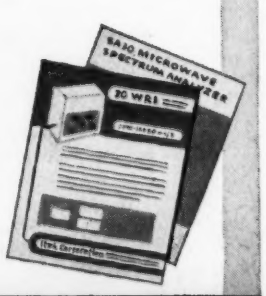

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MSD editorial

OUR NEW NAME

THE SUBTITLE, "Magazine of Systems Engineering," was introduced with our July-August, 1958, issue. This addition excited many favorable comments and prompted a number of readers to suggest an outright change in name for our publication. These readers uniformily stated that to them, the term "Automation" has a limiting connotation that had delayed their recognition of the thorough coverage we have consistently given Military Systems and the components which comprise those systems.

The publisher and editors also appreciate that the term "Automation" is being interpreted in many different ways in the field, causing some confusion as to the purpose and philosophy of this publication. We believe that changing our name to MILITARY SYSTEMS DESIGN will clarify this understanding.

Editorial treatment of electronics, optics, solid-state phenomena, hydraulics, cryogenics and pneumatic devices as related to military systems is essential if full advantage of the "present state of the art" is to be realized. Electronic engineers have an urgent need to understand the characteristics of the electromechanical, hydraulic and pneumatic actuators controlled by their black boxes. Other specialized engineers have an equally urgent need to appreciate the rapidly changing capabilities of new semiconductor and magnetic amplifier circuits. Changing techniques in UHF amplifiers, inertial guidance and infrared are being felt in all Military System areas. Optical and quasi-optical systems are merging with electronics in tracking and reconnaissance systems. The military technical officer must keep abreast of all these rapidly developing technologies as they specifically apply to the design of MILITARY SYSTEMS.

The Military mission dictates the system requirements against which each new product and component must be measured before it is incorporated into a military system. In fact, urgent military requirements are continually calling into existence new materials, components and entire systems. Development of such new systems is today proceeding at an unprecedented rate, due to the teamwork between government and defense industry research facilities.

As stated in our July-August editorial: "Better military systems are the result of teamwork between specialists. The good development team includes mechanical, human factors, production, environmental test and maintenance engineers, along with scientists and electronics design personnel. Military technicians who assess the effectiveness of the system in combat are also present. Each of these specialists needs a basic understanding of all other phases of the system if he is to make his most effective contribution to the team."

The staff of MILITARY SYSTEMS DESIGN will continue to expand the evaluation of new scientific techniques and components to determine their relationship to, and impact on, systems already in being, under development or envisioned. "Passing the word" is our job.

LEGISLATIVE OUTLOOK

OVER THE past several years, observers have often named 1960 as the earliest year by which Russia might be ready to assume a more aggressive international policy. If these estimates have any validity, the first order of business for the Eighty-sixth Congress will be a fresh look at the readiness of our Army, Navy and Air Force to operate now as an integrated global defense team. Concurrent, and no less important, is the necessity to hold our own in the intercontinental missile competition, which includes the Polaris and anti-missile system efforts.

Forthcoming issues of MILITARY SYSTEMS DESIGN will report on some of these measures; also will feature articles on the design of training simulators, environmental and experimental testing, inertial guidance systems, missile ground support systems, electromagnetic detection and communications systems and air traffic control systems as they are affected by the developing new solid-state techniques.

Seasons Greetings

ON behalf of the publisher and staff of MILITARY SYSTEMS DESIGN, we bring our many readers the Compliments of the Season and best wishes for the New Year. New problems in world diplomacy loom in the months just ahead. While arms alone cannot provide all solutions, a strong military posture surely provides the only position from which international measures for peace can proceed. The great responsibility of maintaining our nation's military readiness falls equally upon the ever alert personnel of our Armed Forces and the hard-working scientific and industrial crews who push forward the planning and latest developments in military systems, two groups which together account for most of our readers.

Although few of us will ever know the details of your trials and labors, the continually unfolding developments chronicled in MILITARY SYSTEMS DESIGN bear witness to the magnitude of your task and to the dedication of your effort. These considerations are uppermost in our thoughts as we heartily and prayerfully wish you all—A BUSY AND HAPPY 1959!

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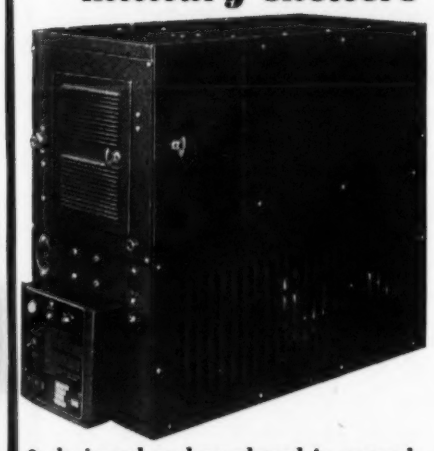

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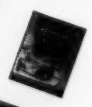

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HEATING AND REFRIGERATION SYSTEMS

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Capacitor Reliability Increased by Fusion Sealing Process

A NEW approach to the old problem of capacitor fabrication, developed by the Electronic Components Department of Corning Glass Works, Bradford, Pa., has been successful in producing units in the 5 to 250 $\mu\mu$fd range which demonstrate an unusual capacity for punishment under Mil-Standard environmental tests. Known as the CYF-10 Fusion-Sealed Capacitor, its copper-clad leads are anchored firmly to the capacitor body by true glass-to-metal seals. The edges of the body are also fused to produce a completely sealed unit, which encloses the glass-dielectric capacitor unit.

The rugged units produced by this process greatly surpass the requirements of MIL-C-11272A in reliability under severe environmental tests. The size 10 capacitors, ⅛ postage stamp size (Fig. 1), are guaranteed to show no significant change in capacitance or dielectric loss after more than 1000 hours in a high humidity atmosphere. They are also guaranteed for 2000 hours life at 125°C with 150% of rated voltage applied. Tests indicate that a dielectric life of 15,000 hrs at 70% rated voltage may be attained.

Temperature coefficient of Fusion-Sealed capacitors will lie between +115 to +165 ppm/°C over the temperature range from —55 to 85°C, with less than 15 ppm°C variation between all capacitors. Capacitance drift is less than 0.05% or 0.1 $\mu\mu$f.

The Fushion-Sealed capacitors are being produced in the new Bradford-Corning plant completed in September 1958. Other products produced here are the Corning all-glass resistors, ranging from miniature sizes to power resistors up to five feet long; glass trimmer capacitors; tiny glass level switches used in connection with missile gyroscopes; and Fotoceram glass for miniaturized electronic circuit boards which an be processed into printed circuits by photography and heat.

For more information on Fusion-Sealed Capacitors circle **38** on inquiry card.

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Kearfott offers the widest range of synchros in the industry. Ruggedly constructed of corrosion-resistant materials, they give unequalled performance under every environmental condition. For best characteristics and reliability, specify Kearfott for all your synchro requirements. Here are a few typical models:

Size 8: .750" x 1.240". 1.75 oz. —54C to +125C.
Available as transmitter, control transformer, resolver, and differential. Max. error from EZ: 10, 7 and 5 minutes.

Size 11 Standard: 1.062"x1.766". 4 oz. — 54C to +125C.
Available as transmitter, control transformer, repeater, resolver and differential for 26v and 115v applications. Max. error from EZ: 10,7 and 5 minutes standard, 3 minutes in 4-wire configurations.

Size 11 MIL Type: Dimensions and applications same as above. Meets Bu. Ord. configurations: max. error from EZ: 7 minutes.

Size 15 Precision Resolver (R587):
With compensating network and transistorized booster amplifier, provides 1:1 transformation ratio, 0° phase shift. Max. error from EZ: 5 minutes.

Size 25 Ultra-Precise: 2.478" x 3.187". 45 oz.
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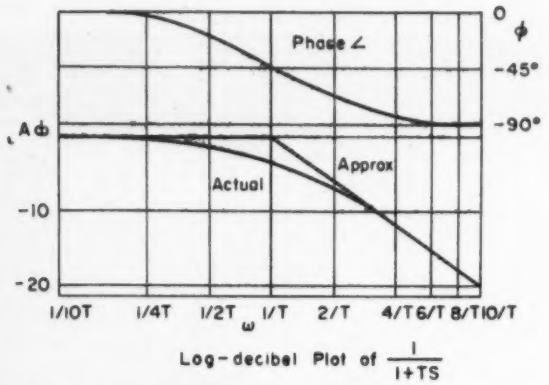

FIG. 1. LOG-DECIBEL and output phase angles plot of transfer function $1/(1 + Ts)$

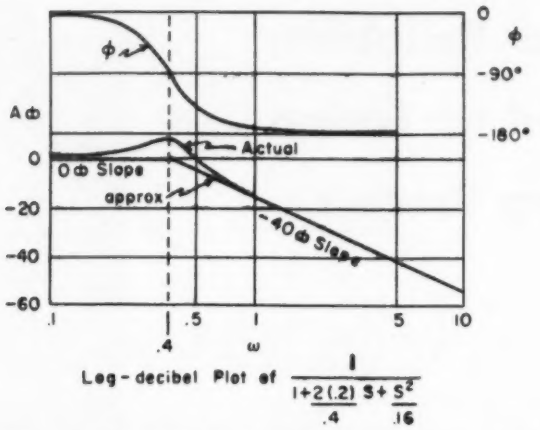

FIG. 3. AMPLITUDE RESPONSE and output phase-angle for second-order system of the form, $1/[1 + 2(0.2)s/0.4 + s^2/0.16]$

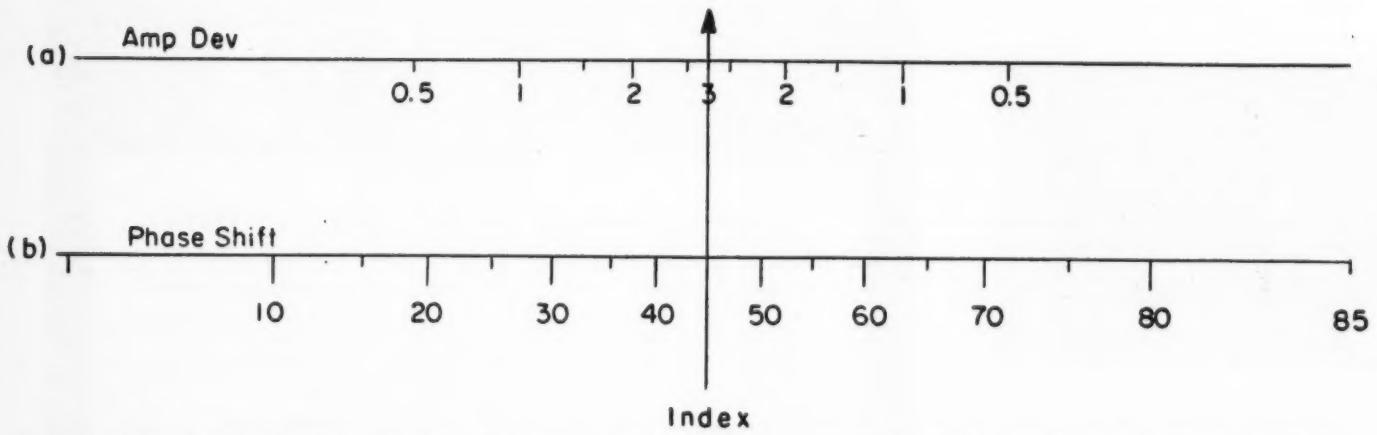

FIG. 2. AMPLITUDE-PHASE deviation scale. Use scale A for corrections to straight-line approximations of amplitude curves for first-order terms. Use scale B to plot points for phase shift curve.

TABLE 1—RULES FOR CONSTRUCTING AND CORRECTING STRAIGHT-LINE APPROXIMATIONS

terms	establishes	slope in db/decade	final phase shift	sign of slope & phase shift	sign of scale deviations
K	initial amplitude	none			
s	initial slope	20	90°	+	none
$\frac{1}{s}$	initial slope	20	90°	−	none
$1 + Ts$	breakpoint at $\omega = 1/T$	20	90°	+	+
$\frac{1}{1 + Ts}$	breakpoint at $\omega = 1/T$	20	90°	−	−
$1 + \frac{2s}{\omega_1} + \frac{s^2}{\omega_1^2}$	breakpoint at $\omega = \omega_1$	40	180°	+	as given in Figs. 4 & 5.
$\frac{1}{1 + \frac{2s}{\omega_1} + \frac{s^2}{\omega_1^2}}$	breakpoint at $\omega = \omega_1$	40	180°	−	opposite sign of that given in Figs. 4 & 5.

TOOLS FOR L

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LOG-DECIBEL plots, commonly called Bode plots, after H. W. Bode, are a useful method of presenting transfer functions of systems for analysis. The plots are formed from the transfer function E_{out}/E_{in} expressed in terms of the Laplace operator "*s*". Engineers working in systems and equipment analysis are all too familiar with the tedious matrix-building substitution of $j\omega$ for "*s*" and calculation of 20 $\log_{10}$ of the E_{out}/E_{in} amplitude relationship at varying frequencies.

These plots show output amplitude gain expressed in decibels greater or less than the input amplitude. Also, the phase of the output signal is compared to the input signal and any output phase shift Φ, is shown against the same abscissa of input frequency.

When the expression for E_{out}/E_{in} in terms of the Laplace operator "*s*" has been simplified as much as possible, it takes one of several standard forms. Rules-of-thumb have been developed whereby straight-line approximations of the true log-decibel plots can be drawn quickly without long calculations (Table I).

The accompanying nomograms are designed to enable the engineer to work from these straight-line approximations to produce faired curves for gain and phase shift as will be shown by the following examples:[1]

All transfer functions expressed in polynomials of "*s*" in the numerator and denominator can be reduced to factors consisting of constants, lone "*s*" terms, first-order terms, and second-order terms. Table I lists the standard forms these factors take and shows the influence each contributes to the construction of

[1]Note: The scales (Fig. 2) and the nomograms (Figs. 4,5, & 6) are printed full scale for use in constructing curves on 3-1/3" three-cycle semi-log graph paper usually used for these plots.

LOG-DECIBEL PLOTTING

Engineers working with open and closed-loop transfer functions can save a significant portion of their time by using the nomograms here described for plotting gain and phase-shift curves without tedious calculations.

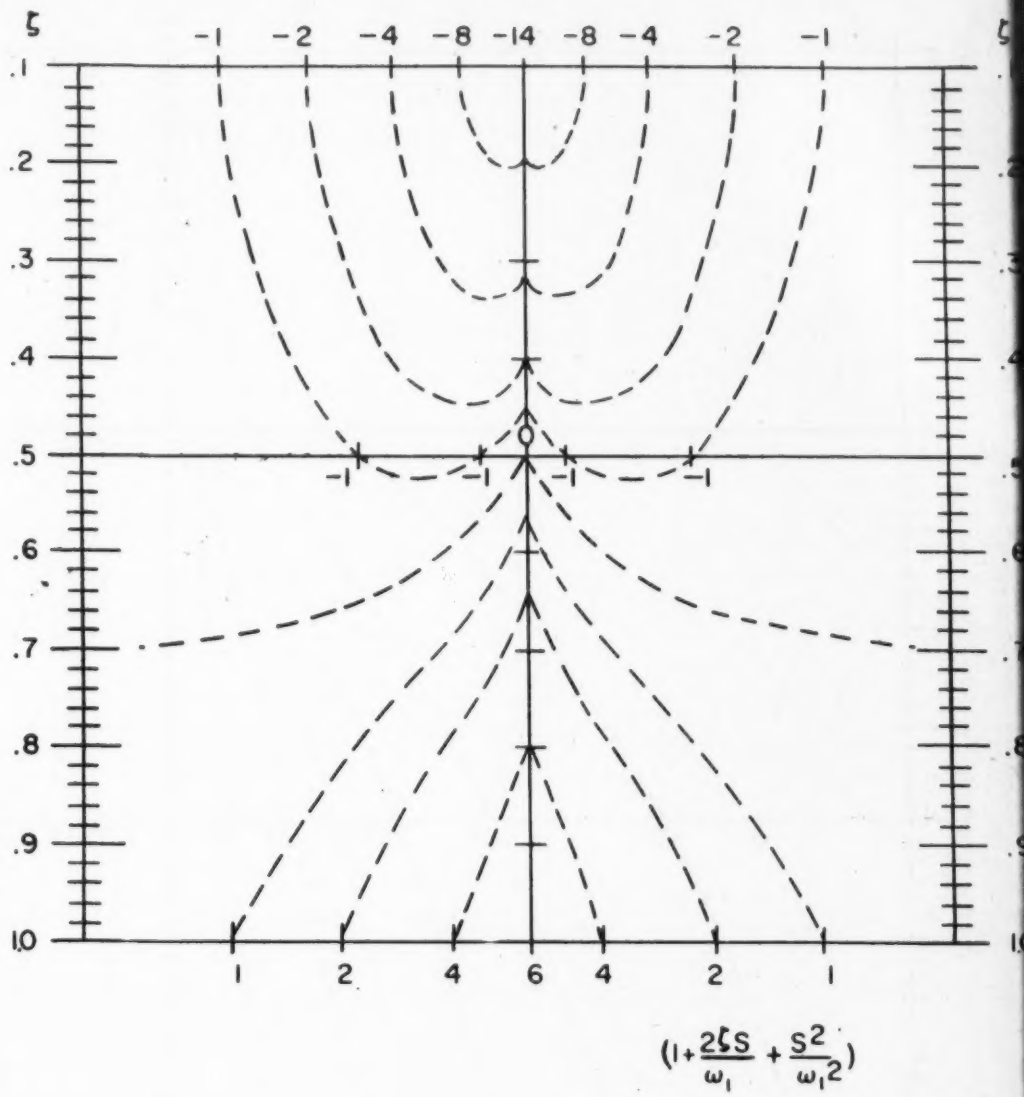


FIG. 4. AMPLITUDE CORRECTION for second-order factors. Correction scale for each case is constructed from this nomograph.

straight-line approximations of gain. When working with several such terms, care must be exercised to be certain of applying their influence in the proper direction. This is done by adding influences algebraically when more than one rule applies.

Example 1

Plot the curve $1/(1+Ts)$ (Use semilog graph paper with three 3 1/3″ cycles along the abscissa). Lay out a scale containing the cycles 0.1/T, 1/T and 10/T along the abscissa and $A_{db} = (0, -20)$ along the left ordinate as in Fig. 1.

There is no constant, or lone "*s*" factor, so the gain curve originates at 0 db and moves parallel to the abscissa until the break point at 1/T. The single-order "*s*" is in the denominator so the line is given a −20 db/decade slope. Your graph should look like the straight-line approximation shown in Fig. 1.

Fig. 2 may be reproduced on tracing cloth so that it can be superimposed on your straight-line approximation with the index of the scale vertical at the break-point or corner frequency, 1/T. The numbers on the A scale (Fig. 2) represent the difference, in db, between the approximation and the true curve at the ordinate passing through those numbers on either side of the corner frequency. These db values will be subtracted or added in accordance with Table I to give points through which the true curve will be faired. In this case the values are subtracted, because the "*s*" term is in the denominator in the expression $1/(1 + Ts)$.

Now refer to the B scale on Fig. 2. Without moving the index from the corner frequency, plot the phase-shift values shown on scale B on the chart. Your phase-shift scale should range from 0° to −90° (see Fig. 1). Note: The plot of $(1 + Ts)/1$ would be a mirror image of Fig. 1 having both slope and phase shift positive.

Example 2

Take the function:

$$\frac{1}{1 + 2\zeta/\omega_1 + s^2/\omega_1^2}$$

where $\zeta = 0.2$ and $\omega_1 = 0.4$

Lay out scales on three-cycle semilog paper like those shown in Fig. 3 and draw the straight-line approximation. The corner frequency is at 0.4, and the line has a slope of −40 db/decade from the corner because "*s*" is a second-order term in the denominator. Your straight-line approximation should look like that shown in Fig. 3.

The scales of Fig. 2 are valid only for first-order terms of "*s*". However, using the nomograms of Figs. 4, 5, or 6 the correct scales for second-order terms can be made. Figs. 4 & 5 give amplitude variations for different ranges of ζ. Fig. 6 gives phase shift for different ranges of ζ. It is suggested that these nomograms be accurately reproduced (same size for use with three-cycle graph paper) and mounted in pairs for convenience in use.

To make the amplitude scale, lay the top edge of a sheet of paper on Fig. 4. The value given for ζ is 0.2 so align the top edge with the 0.2 points on the right and left scales of Fig. 4. Place marks at the edge of the sheet wherever the dotted lines of constant deviation intersect the edge; the center line is the index. The values of these dotted lines are given at the top of Fig. 4; note, they are negative numbers. The top edge of your paper thus becomes a scale similar to that of Fig. 2, A.

Use the scale you have just constructed by placing the index at the corner frequency on your chart and correcting the straight-line approximation by the amounts shown on the paper scale. Note: The amplitude deviations given at the top of Fig. 4 are subtractive, but the quadratic is in the denominator, also a subtractive effect, making the net additive to the approximation.

A scale for phase shift is constructed in similar

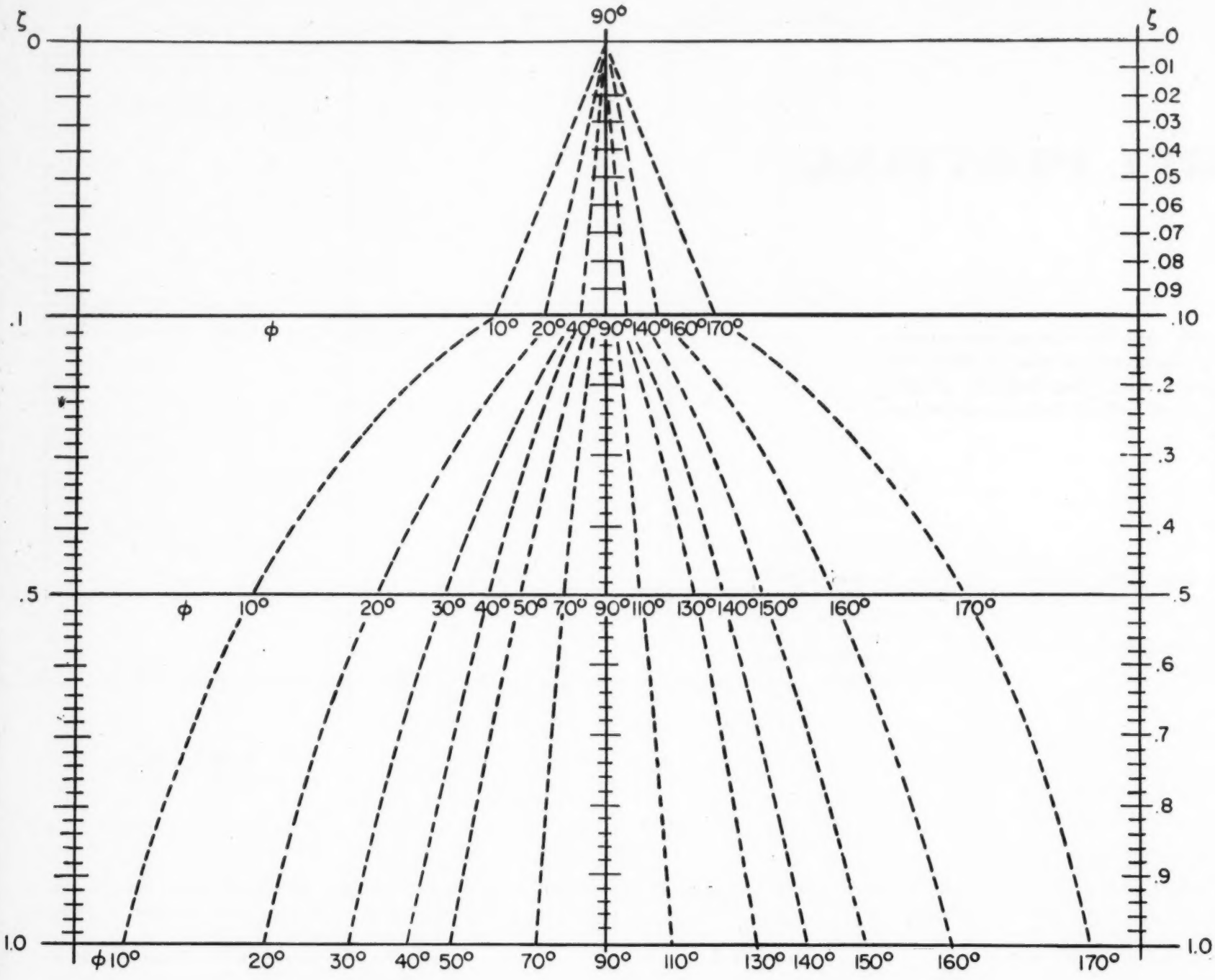


FIG. 6. PHASE-ANGLE scale nomogram for plotting output phase-angle effect of second-order factors of the form

$$1 + 2\zeta\frac{s}{\omega_1} + \frac{s^2}{\omega_1^2}$$

manner, laying the edge of a sheet of paper across the Fig. 6 nomogram at $\zeta = 0.2$. The phase angle is then plotted on the chart as before, resulting in the curve shown in Fig. 3.

Example 3

The methods previously illustrated can be combined in plotting this more complex function:

$$0.0315(1+10s)/s[1+2.5s][1+2(0.8)s/4+s^2/4^2]$$

This curve is constructed in the following steps:

Step 1. Reduce the expression to:

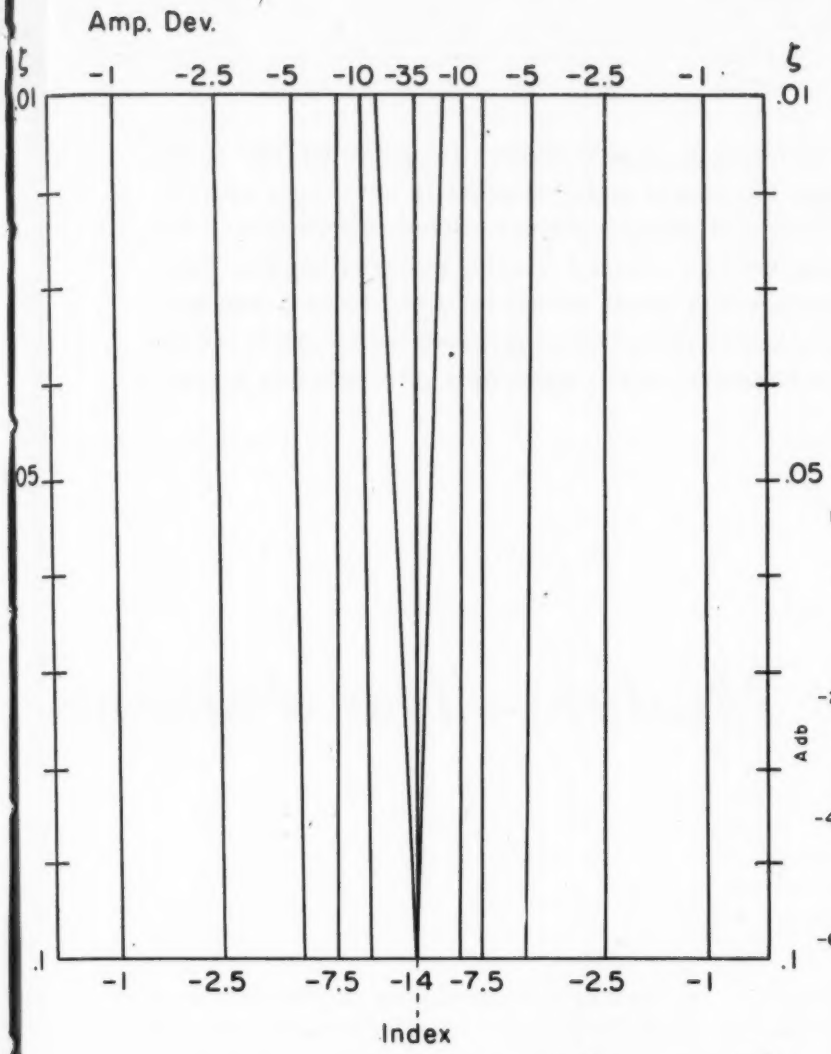
$$(0.0315)\left(\frac{1}{s}\right)(1+10s)$$

$$\left(\frac{1}{1+2.5s}\right)\left(1+\frac{2(0.8)s}{4}+\frac{s}{4^2}\right)^{-1}$$

Step 2. Corner frequencies will be located at $a = 1/T$ for each of the first and second-order terms, where T is the coefficient of *s*. Therefore break points will be at $a = 1/10$, $1/2.5$, and at $1/\frac{1}{4}$.

Step 3. Lay out scales to accommodate the corners $\omega = 0.1$, 0.4, and 4 and a range of about 70 decibels; i.e., 20 for $1/s$, 0 for $(1 + 10s)$, 20 for $1/(1 + 2.5s)$, and 30 for the quadratic.

Step 4. The constant term 0.0315 determines the ordinate value at $\omega = 0.01$. $20 \log \frac{0.0315}{0.01} = 10$ so the plot is started at $A = +10$ db. The initial slope is -20 db/decade because of $1/s$. The first corner is at 0.1 where $+20$ db is added to the slope because of the first-order numerator term $(1 + 10s)$. The next corner is at 0.4 where -20db/decade is added to the slope



$$\left(1 + \frac{2\zeta s}{\omega_1} + \frac{s^2}{\omega_1^2}\right)$$

FIG. 5. AMPLITUDE CORRECTION nomogram extended for values of ζ between 0.01 and 0.1.

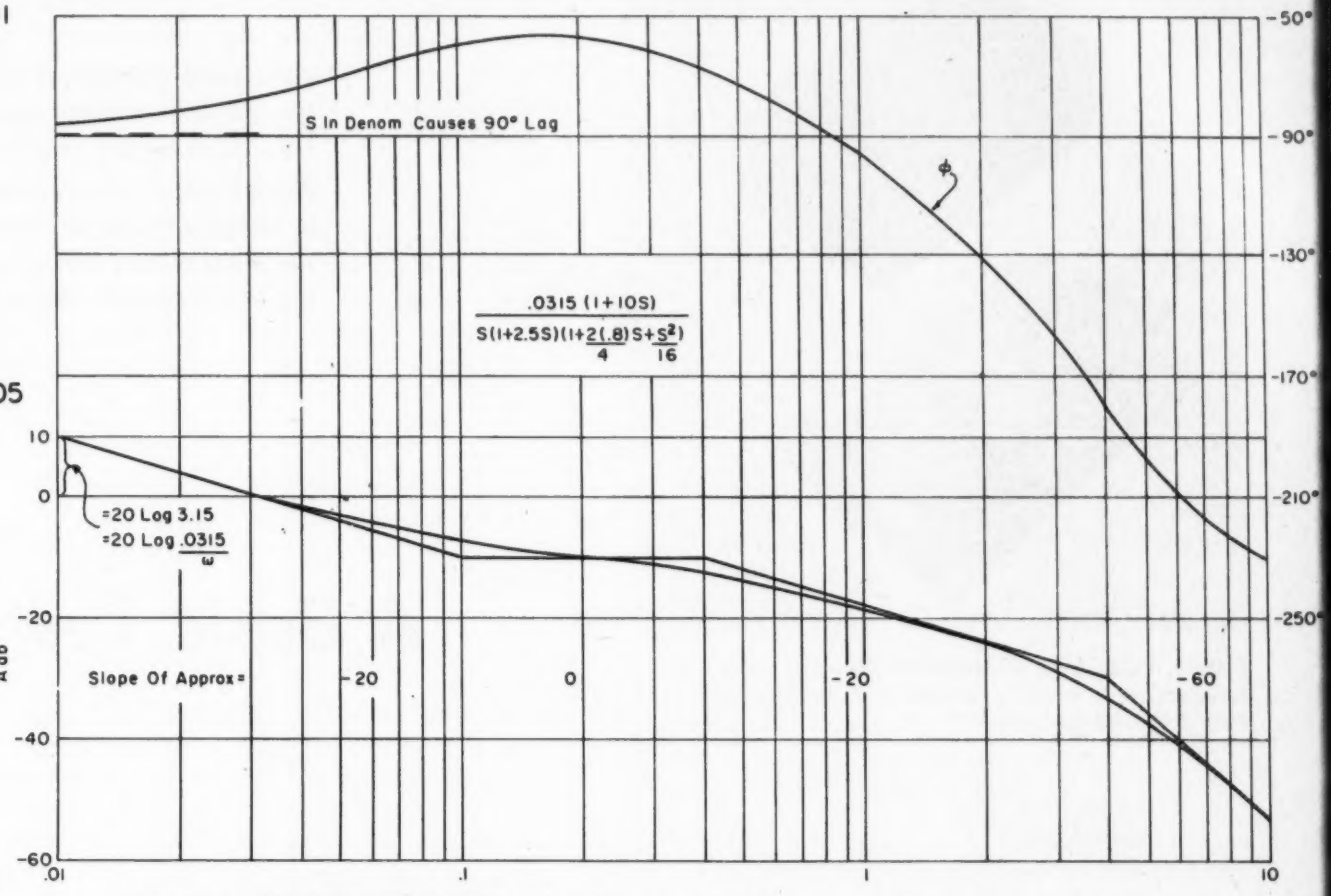


FIG. 7. AMPLITUDE RESPONSE and outlet phase-angle curve constructed by use of nomograms for complex transfer function.

because of the first-order denominator term $1/(1 + 2.5s)$. The last corner occurs at 4, where -40db/decade is added to the slope because of the quadratic in the denominator.

Step 5. Fig. 2 scale A is used to determine the deviation at the corners $\omega = 0.1$ and $\omega = 0.4$. The former is additive and the latter subtractive. First place the index of Fig. 2 on the ordinate corresponding to $\omega = 0.1$, mark the deviation and fair in a curve with a light dashed line. Then place the index at the ordinate $\omega = 0.4$ and mark the deviations on both sides of that index. This is done because the deviations overlap, and the second deviation is added to the first dashed line to get a *resultant* curve. Again fair in a light dashed curve.

Step 6. Place the edge of a sheet of paper on Fig. 4 on a straight line connecting $\zeta = 0.8$ on the side scales. Mark the paper where the lines of constant deviation intersect the edge. Note that the deviation at the index is slightly more than 4 decibels. Place the index on the ordinate corresponding to $\omega = 4$ and mark off the deviation; making it subtractive because it was positive in Fig. 4 and the quadratic is in the denominator. Where the deviations overlap, add the last corrections to the previously drawn dashed line to get a resultant.

Step 7. Draw the whole resultant curve.

Step 8. Make a phase-shift scale from Fig. 6 at ζ=0.8. Also note from Table I that the 1/s term will start the phase-shift plot at $-90°$, it will rise 90° then fall 90° because of the first-order terms, then fall about 50° (within the limits of our graph) because of the quadratic in the denominator. Because additional room will be required for the step-by-step construction of the phase plot, move to a work sheet laid out in the same Φ scale, but with room for an initial 90° rise in the graph.

Step 9. Lay the index of the scale of Fig. 2 on the ordinate corresponding to the first corner and fair in a dashed curve showing the *lead* phase of the $(1 + 10s)$ term alone. Move the index to the next corner frequency and plot the *lag* shift of the term $1/(1 + 2.5s)$, working from the first dashed curve. Fair a new dashed curve corresponding to the resultant of the two first-order terms. Then lay the index of the scale made above at Step 8 on the next corner frequency and make another dashed curve. Now determine the final resultant phase-shift curve. Transfer this to the smooth copy for the complete plot of the function, which should be equivalent to Fig. 7.

Reference

1. Floyd E. Nixon, Principles of Automatic Controls, Prentice-Hall, Inc., 1956 pp 165-174.

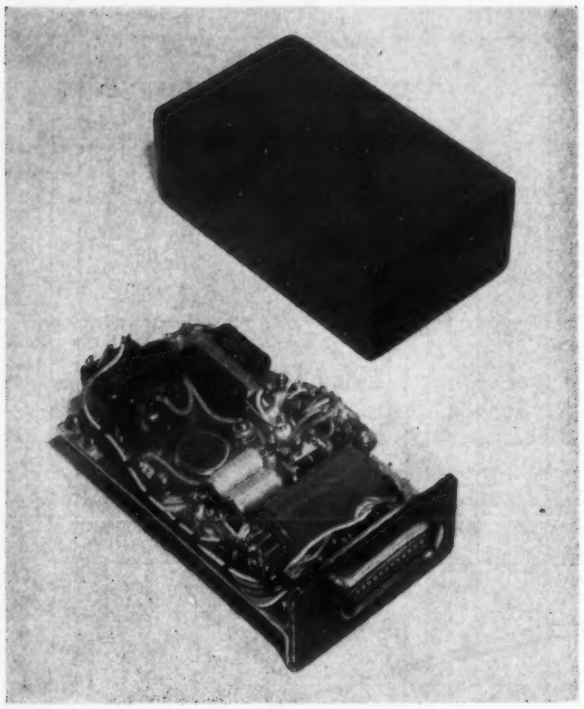


FIG. 1. VOLTAGE COMPARISON unit, subminiature in size, is a highly reliable and sensitive GO—NO GO voltage gage.

Automatic voltage comparison as used in digital computer circuits is the basis of a new subsystem component which appears to have wide applications in weapons checkout and routine military system maintenance. The down-time of any system may be reduced greatly by an automatic built-in diagnostic check circuit which would detect incipient failures and malfunctions before they occur and without interruption to the normal functioning of the system. The new module also is applicable to production testing.

A Basic Test Module—The Voltage Co

AUTOMATIC GO—NO GO testing, applied to weapons checkout and missile support equipments, is being implemented by a new subsystem component, the voltage comparator. Point-to-point voltage tests, long a diagnostic aid for the maintenance technician, were time consuming when done manually. Reduced to a programmed and automatic technique, such tests are now made with digital-computer speed and the results can be applied as a visual or audible alarm, recorded by printout, used to automatically classify components, or to actuate control mechanisms to correct the off-normal conditions which the comparator has detected.

The comparison measurement is made possible by the many transducing components commercially available to transform physical phenomena to electrical quantities. This conversion of all variables to a common denominator of voltages in turn allows the systems engineer to unify and meet diverse monitoring and control requirements in a compact centralized instrumentation center. There each signal can be monitored, either continuously or intermittently according to system requirements, automatically compared with its corresponding standard, and off-normal conditions identified, recorded or corrected. In the field of physical measurement, the same type of automatically responding monitor can supplement visually-indicating instruments.

To be versatile and effective in various comparison applications, a comparator must have: High sensitivity, high input impedance, ability to compare ac or dc voltages, low power requirements, phase or polarity sensitivity, ability to distinguish between in-phase and quadrature components of ac signals, and operational stability over wide temperature ranges and under severe environmental conditions.

The 200 Series transistorized voltage comparator developed by the Trio Laboratories, Inc., Plainview, N. Y., is said to meet these requirements in a miniaturized component (Fig. 1) which maintains its high performance characteristics over an ambient temperature range from —55° to 55°C. It also meets the applicable requirements of MIL-E-5272.

Automatic checkout and monitoring procedures are generally employed where large quantities of data are to be handled. In addition, airborne uses require small size and light weight. These applications, therefore, dictate the use of transistors with the associated low power requirements. A typical Trio Labs. ac responding instrument utilizes less than one-tenth of a watt from a 115 v ac line source under zero input conditions. The transistor circuit within the comparator is utilized to control a DPDT relay making possible tremendous power gains.

Circuit Operation

The block diagram, Fig. 2, illustrates the systems design used in the Model 201-1 DC Voltage Comparator meeting the performance specifications previously listed. It features a chopper input to convert the dc error voltage to an ac signal. Two stages of emitter—follower are next utilized to realize a minimum input impedance of two megohms. The impedance converter drives a three stage transistorized amplifier which in turn feeds into a phase-sensitive diode bridge. The reference frequency signal is utilized in the bridge circuit as a switching voltage. Alternate halves of the reference voltage switch the diodes to a conducting condition, resulting in operation of the bridge within the high conduction region of the diodes. The bridge then efficiently converts ac voltage signals to proportional dc levels.

The effective output of the phase-sensitive bridge is a dc voltage proportional to the ac error signal. A two stage dc amplifier employing controlled positive feedback then amplifies the output of the phase-sensitive bridge. The action of the feedback amplifier is regenerative, acting as a switching circuit to control the output relay. Full dc power supply voltage is applied to the relay under "ON" conditions to insure positive locking action.

The overall action of the comparator thus provides a rapidly responding relay closure when the unknown signal exceeds a constant set input voltage. By simply reversing the two input leads, the comparator can be used to provide relay closing if the unknown signal is less than the reference level. The combination of

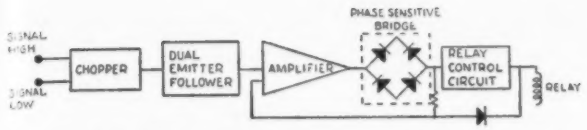


FIG. 2. **DC VOLTAGE** Comparator block diagram.

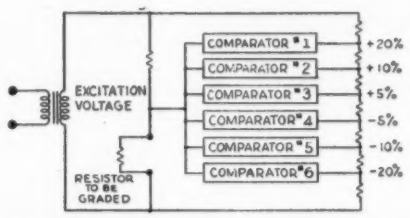


FIG. 3. **AUTOMATIC** Resistor Grading System, using Trio Laboratories, Inc., 200 Series Voltage Comparators.

e Comparator

high gain and high input impedance results in an overall effective sensitivity of 0.005 microamperes. Considering that the required operating power of a standard micro-miniature DPDT relay is 350 milliwatts, the comparator provides a power gain of approximately 10^{13} exclusive of the power gain due to the relay itself.

Bridge Circuit Applications

The comparator circuit is also particularly suited for bridge type measurements, according to its developers. The phase-sensitive diode circuit employed in the instrument is basically insensitive to quadrature components of the voltage input. This characteristic is derived from the switching action of the reference excitation to the diode bridge and to the integrating action of the ac to dc conversion. Specifically, the dc level applied to the output switching circuit is the average value of the ac appearing at the output of the amplifier section. The average value of any voltage component which is 90° out of phase with the reference voltage is zero. Harmonics of the fundamental frequency are similarly attenuated. This feature is particularly interesting in bridge type measurements since harmonics and quadrature levels are generally high in relation to the fundamental in-phase difference voltage.

Bridge measurements also require the use of "infinite" detectors to minimize loading of the bridge. As an example, consider the use of the comparator in an automatic resistor sorting application (Fig. 3). Resistors to be graded are placed in one leg of the bridge. A resistor under test which was higher than nominal by over 10% but less than 20% higher would result in Comparator #1 relay being de-energized and all the other being energized. The relay contacts are easily tied in series in a simple logical circuit to initiate the proper sorting procedure to make thousands of selections per minute. Where economy takes precedence over speed, a simple rotating switch can be employed to sequentially feed each reference voltage into the comparator. The grading or selection would then be determined by the position of the rotating switch.

Automatic Checkout Circuits

The comparator is considered to have many potential uses in military systems since missile and aircraft ground support, airborne instrumentation, test equipment and similar data gathering and processing systems all require some type of comparison. As an example, a tape can be pre-punched with reference data. This would include a code number for test identification and the upper and lower limits established for that test point. The punched tape is programmed through a tape reader and a digital-to-analog converter to present the information in analog voltage form. The test signal is fed simultaneously into two comparators—one designated as the lower limit comparator while the other is the upper limit comparator. The information from the punched tape is channeled into the proper comparator. Each pair of comparators simultaneously and rapidly checks each test point. Several sets of comparators and tape systems can be utilized to decrease the total test time. Conversely, where few points are to be monitored, resistor chains can be utilized to store the upper and lower limit information.

Other System Applications

The comparator is applicable as an automatic controller or safety valve. Conventional over-or-under voltage relays draw a considerable amount of power from the source. Where no loading of the source is permissible the comparator is the ideal instrument. The comparator is also ideal for calibration checking of voltage sources. Whenever a standard cell is the reference to be compared periodically to the voltage output of various power sources, its negligible loading of the source and high sensitivity make it the instrument of choice.

Basically, the primary value of the voltage comparator lies in the opportunity of simplifying test and control equipment design which it affords the system engineer. The combined factors of high-gain, phase-sensitive performance, ability to respond to either ac or dc voltages, together with its small size and low power consumption make this new instrument a promising component for military system applications.

For more information on Voltage Comparator circle **39** on inquiry card.

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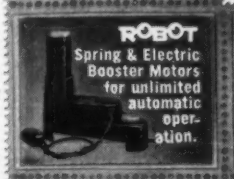

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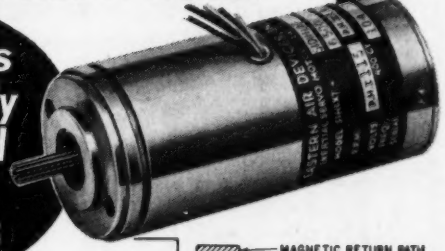

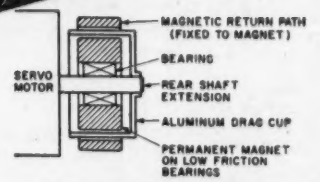

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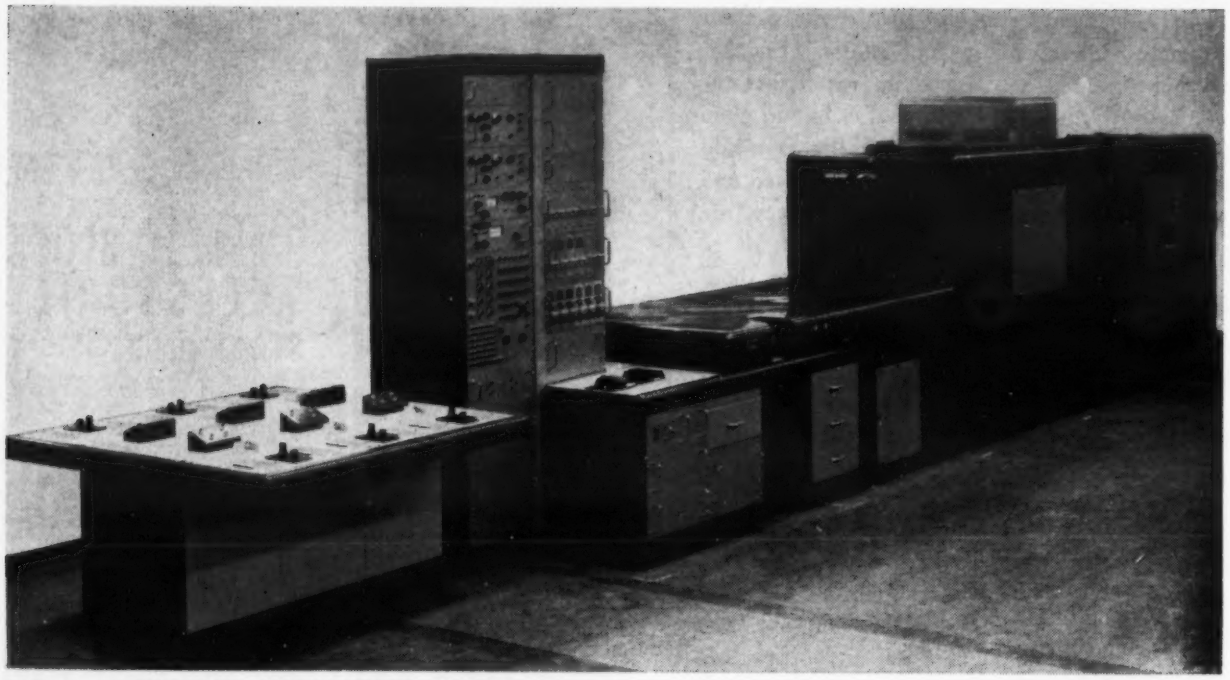

FIG. 1. AUTOMATIC TRANSISTOR TESTER designed for high-speed accuracy in complicated testing to military specifications applies elevated temperatures in one stage of the testing.

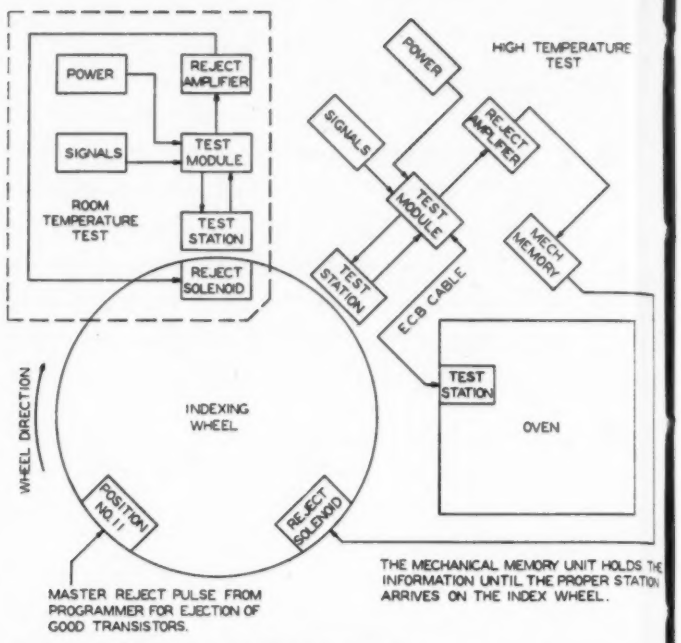

FIG. 2. TYPICAL CHANNEL TEST operation at room temperature is compared to operation at elevated temperature. Note function of mechanical memory.

Transistor Tester Checks Mil-Spec Tolerances

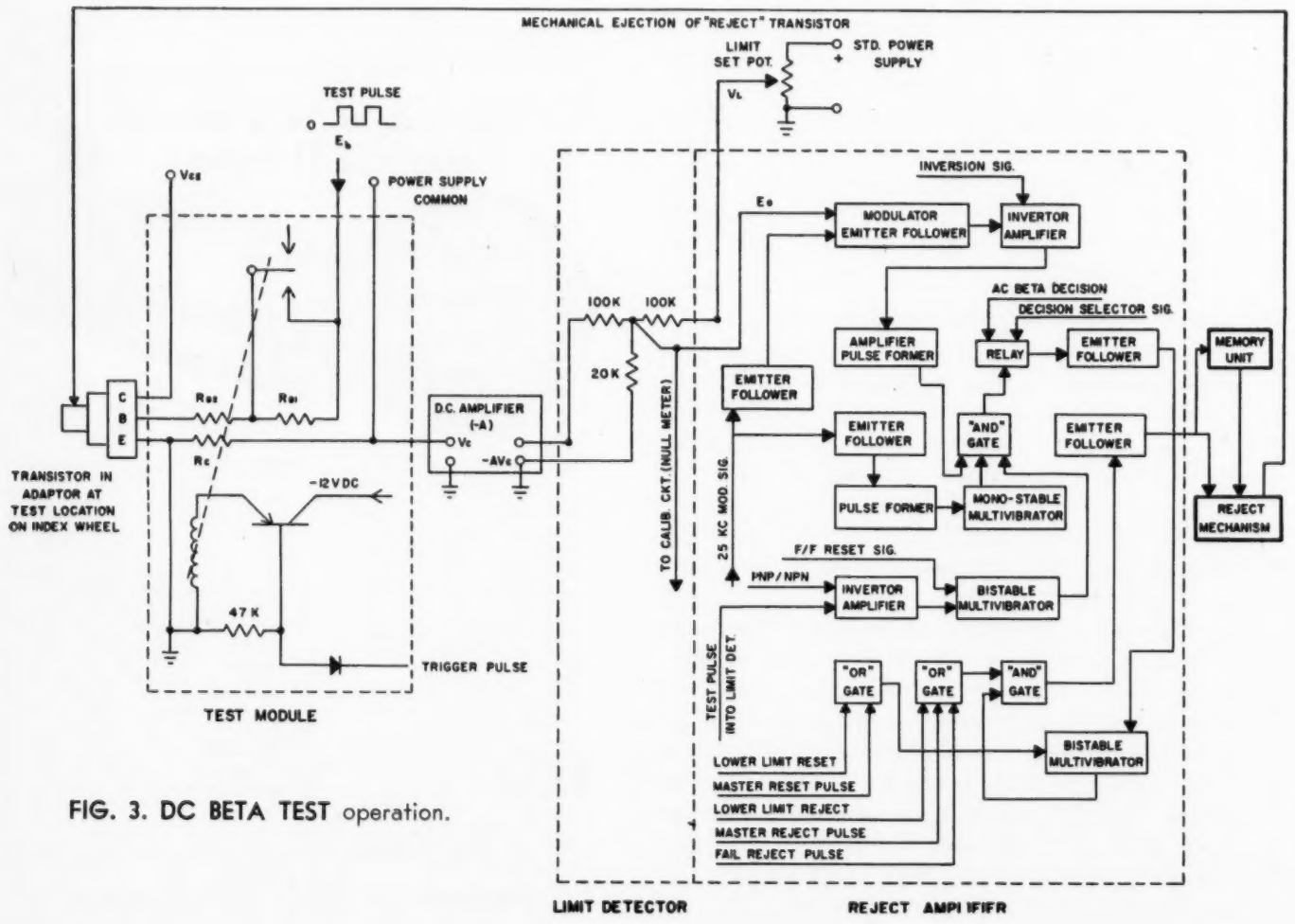

FIG. 3. DC BETA TEST operation.

MR. FRANK McGINNIS, Manager of Quality and Reliability Control, Sperry Gyroscope Co., at the unveiling of a new automatic transistor tester completed to their specifications by the Stromberg-Carlson Division of General Dynamics Corp., Rochester, N. Y., explained that "they had been burned on defective tubes in former military contracts and didn't want the same thing to happen with the new transistors".

The Sperry requirements for an automatic transistor tester grew out of their contract with the Air Force for a transistorized countermeasures equipment. Manual testing, which appeared necessary to ensure the high quality of transistors for successful completion of this contract, loomed as a major production item. Because military specification limits were set to extremely close tolerances, manual test methods would require highly skilled personnel, using delicate and costly instruments, and many parallel test stations would be required to handle the large number of transistors needed. Even with such an outlay, high reliability of results could not be guaranteed because of the human factors involved in manual testing.

After study of the problem with Stromberg-Carlson engineers and with leading transistor manufacturers,

Stromberg-Carlson was awarded a contract to design and build an automatic transistor tester. This must be capable of tests for dc beta (pulse test), ac beta (small signal test), saturation and leakage. It also must be capable of making any of these tests at elevated as well as normal room temperatures. This (Fig. 1) is the instrument which was recently delivered to the Sperry Gyroscope Co., for use in their Great Neck, Long Island plant. Mr. McGinnis asserted that he believes this equipment will be of immeasurable value to the Air Force and to the transistor industry in general.

One unique feature of the S-C tester is the temperature chamber in which the transistors can be subjected to any one of the series of tests while being operated at any preselected temperature from 50°C to 200°C. If failure occurs on this test, a mechanical memory feature holds the results until the transistor reaches the proper station on the index wheel where it is rejected. Transistors are gradually lowered to room temperature after leaving the high temperature chamber.

Only one operator is needed to load the tester which can perform seven different tests sequentially on up to 430 transistors per hour. The transistor is placed on the indexing wheel which carries it from one test to the next (Fig. 2). Each test is of the GO, NO-GO type, and each is governed by a separate module (Fig. 3). This modular organization of test circuits permits rapid replacement of modules in the event of maintenance trouble. Programming of tests and test conditions are established by two punched cards which are inserted into card readers.

All tests require the presence of an acceptable test signal to prevent rejection. This feature ensures that transistors will not be accepted due to some failure in a test circuit. The transistors are rejected at any station at which failure occurs. This classification of failed units by type of failure, affords valuable control information to the transistor manufacturer.

Modular design in the tester helps avoid obsolescence by permitting a rapid change of test parameters for testing a wide variety of components and sub-assemblies. Sixty built-in trouble indicators not only warn the operator of trouble but pin-point the circuit in which trouble has occurred to minimize down time and maintenance labor. Transistors are used wherever possible to achieve maximum reliability in the tester, which is rated for continuous 24 hr/day operation.

An automatic diode tester designed to perform forward voltage, reverse leakage, zener voltage and zener impedance tests is also under development. In addition, Stromberg-Carlson is developing additional modules which will permit extending the capabilities of this tester to include capacitators, resistors and other components which must meet exceptionally high military requirements.

For more information on
Automatic Transistor Tester circle **40** on inquiry card.

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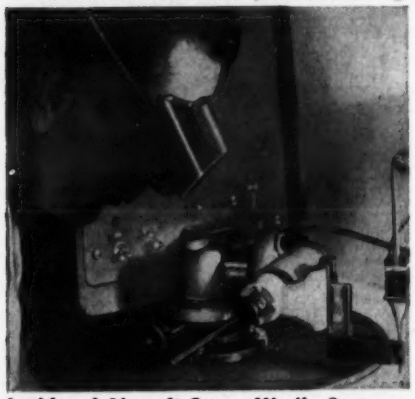

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FIG. 1. NEW ELECTROHYDRAULIC SERVO valve features high sensitivity and performance combined with rugged reliability credited to unique large aperture springless design.

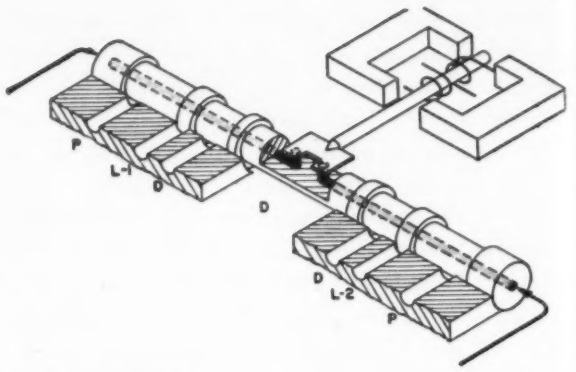


FIG. 3. VALVE at rest, pressures at ends of spool are balanced.

Electrohydraulic Se

MISSILE and high-performance aircraft control systems are always concerned with high reliability under rugged environmental conditions, a large power to weight ratio, high power handling capacity and a relatively fast response. An examination of the operating principles of the new Kearfott 6100 Series Electrohydraulic Servo Valve indicates that it qualifies for a high score on all counts.

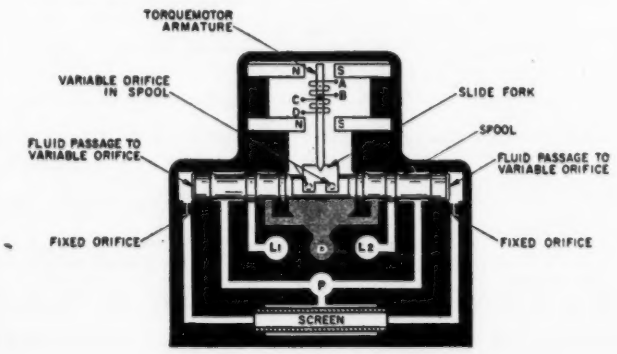
The 6100 Servo Valve (Fig. 1) is basically a two-stage, four-way selector valve. A dc torque motor operating a slide-fork variable orifice valve constitutes the first stage (Fig. 2). The power stage consists of an accurately matched spool and sleeve. Operation of the servo valve is readily checked by reference to Figs. 3 to 6.

Fluid under supply pressure (500 to 3000 psi) enters input port P and passes through the filter screen through fixed orifices to chambers at each end of the spool. Two passages leading through the center of the spool connect from the chambers to the two variable orifices located at either side of the spool's center line. A slider fork, attached to the motor armature, closes the two variable orifices at null.

With the valve at rest (Fig. 3) an increased current flow through one of the windings, say A-B>C-D, displaces the pivoted armature counter-clockwise which positions the slider fork to the right. This uncovers the variable orifice (Fig. 4) connected with the pressure chamber at the right-hand end of the spool. Fluid in the right chamber then escapes through the right variable orifice to the drain port, D. Higher pressure in the left chamber then drives the spool to the right until the exposed variable orifice slides under the fork. The pressures in each of the chambers are then equalized (Fig. 5). The movement of the spool to the right has connected load port L_2 to drain and load port L_1 to the supply pressure port, P.

If current flow in the two coils A-B and C-D is now equalized, the slide fork will be brought back to the center position which uncovers the left variable orifice. The left-hand chamber is then connected to the drain port and low pressure, which allows the pressure in the right-hand chamber to drive the spool to the left until both variable orifices are closed at center position. This spool movement closes load ports L_1 and L_2

FIG. 2. ELECTRIC and Hydraulic stages of 6100 Series Servo Valve.



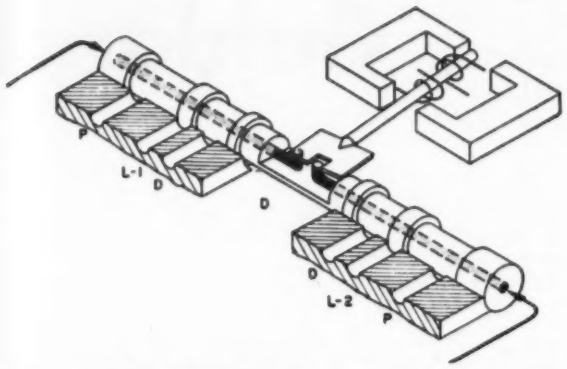


FIG. 4. **TORQUEMOTOR** actuated uncovering righthand variable orifice, releases pressure in pressure chamber at right end of spool.

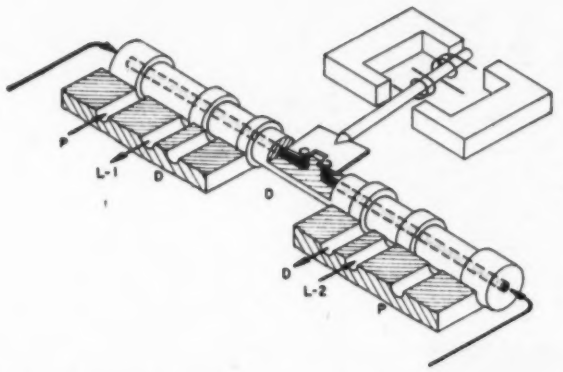


FIG. 5. SPOOL is driven to right by imbalance between hydraulic high pressure in left pressure chamber and low pressure in right pressure chamber, until right variable orifice moves under slide fork.

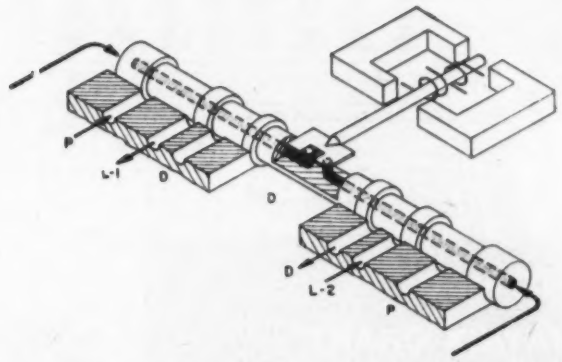


FIG. 6. TORQUEMOTOR positions slide fork in center, uncovering left variable orifice. Pressure imbalance forces spool left to center.

ic Servo Valve Actuator

from both the drain and supply ports.

Conversely, increasing the flow of current through winding CD over AB positions the spool to the left of center (Fig. 6), connecting supply-pressure port P to load port L_2, and load port L_1 to the drain port, D.

Although the movements just described were full excursion movements produced by full differential input current signals, smaller input signals produce proportionally smaller spool movements and consequently lower fluid flow. Load pressure vs differential current performance of the valve is shown in Fig. 7. Its high frequency response is said to be flat to 3 db at 120 cps. Valve ranges of 0-2, 0-5, and 0-10 gpm at 3000 psi are available.

The performance of the servo valve in operation reveals characteristics which are not apparent from a simple description of its operation. One of these is that the hydro-mechanical feedback loop consisting of spool position, variable orifice, and pressure chamber nulls out orifice variations produced by silting common to flapper nozzle designs, in addition to supply pressure and temperature variations. No springs, setscrews or flapper-nozzle adjustments are used, which eliminates many usual sources of failure, hysteresis and null shift. Final null flow adjustments are made electrically by a balancing control at the amplifier output stage.

Another advantage arises from inherent dither, produced by flow of oil through the variable orifices, acting directly on the spool to lower static friction errors, and eliminating the need for external dither-producing arrangements. Quiescent flow of the valve is from 0.05 to 0.15 gpm, depending on supply pressure.

Filtered oil is admitted to the torque motor which is of stale design to give additional cooling and damping to the motor. This is an important factor in achieving an operational temperature range of —65° to 275°F in standard design with higher temperatures on special order. Dry seal motors are also available from the manufacturer, Kearfott Co., 1500 Main Ave., Clifton, N. J.

Variable orifices used in the 6100 Series Valve are over ten times as large as commonly used in conventional flapper-nozzle construction, resulting in greater reliability because of freedom from dirt and metal particles usually trapped in flapper valves. Also, low temperature sludge has a larger flow path. Particles flowing through the second stage are readily sheared.

A combination of the 6100 servo valve with a linear actuator with the torque motor mounted on the common actuator-valve body provides a highly reliable component in which weight and volume are a mimimum. Feedback devices of any type are said to be available, supplied integral with the actuator or mounted externally.

For more information on Electro Hydraulic Servo Valves circle **41** on inquiry card.

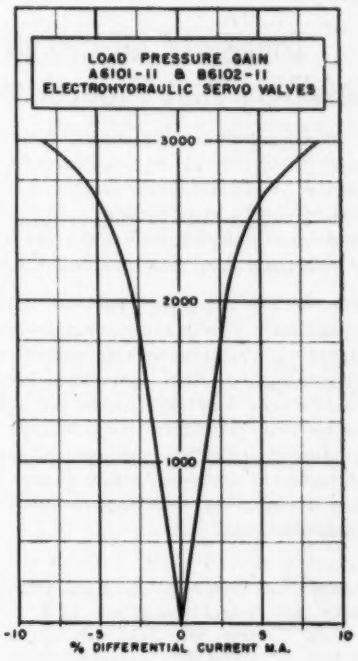
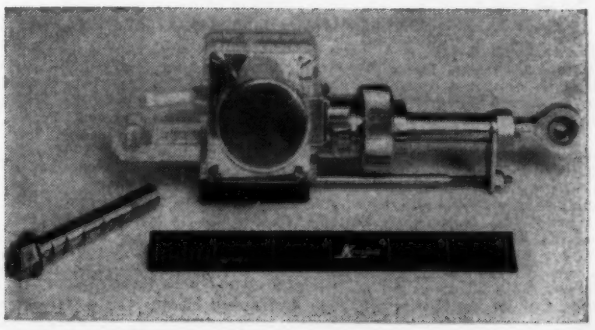
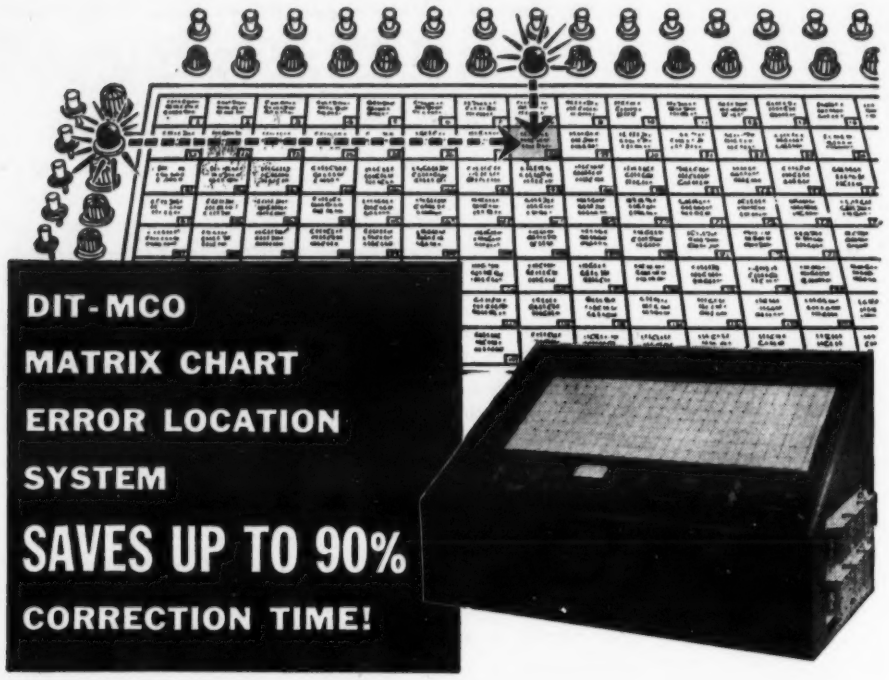


FIG. 7. LOAD PRESSURE vs differential current shows tremendous power-gain capacity of electrohydraulic servo valve.

FIG. 8. ELECTROHYDRAULIC 6100 Servo Valve is combined with a linear actuator in a reliable and powerful miniature unit.





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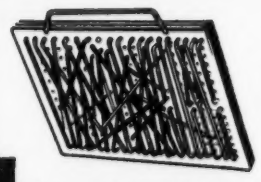

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For more information circle **10** on inquiry card.

Guidance By

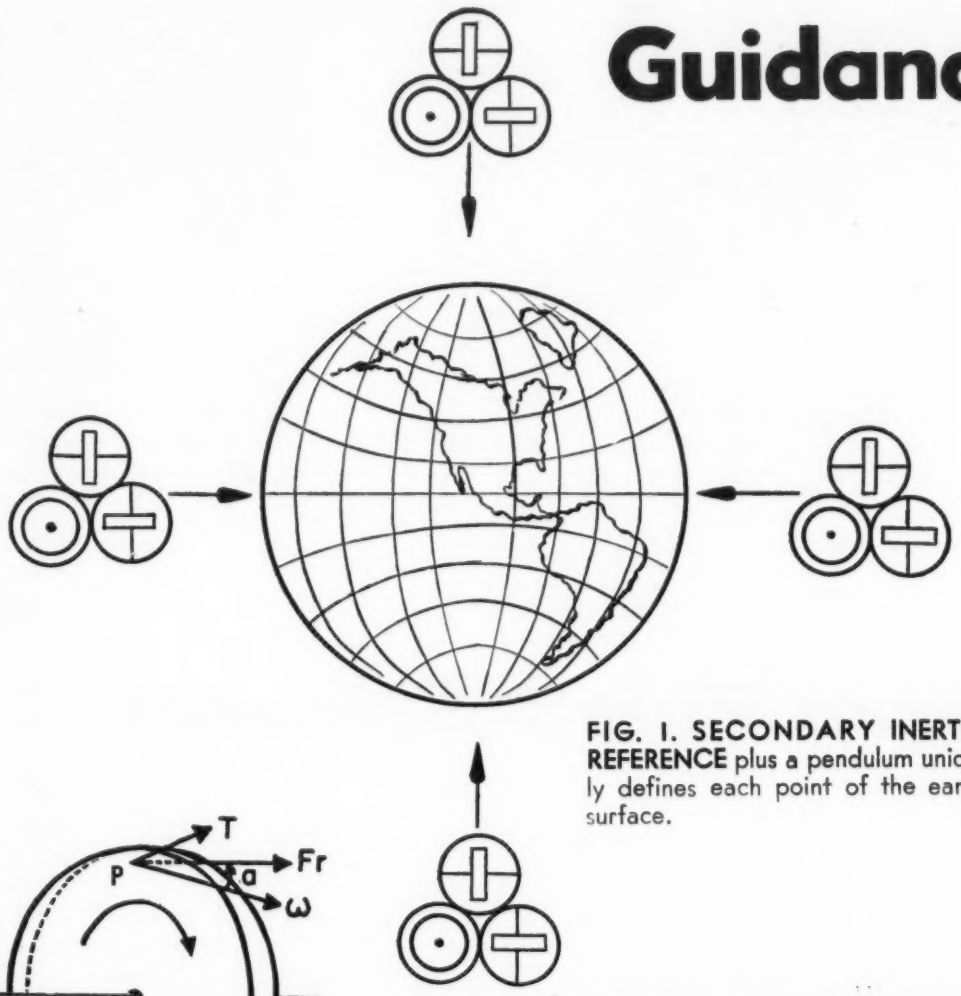


FIG. 1. SECONDARY INERTIAL REFERENCE plus a pendulum uniquely defines each point of the earth's surface.

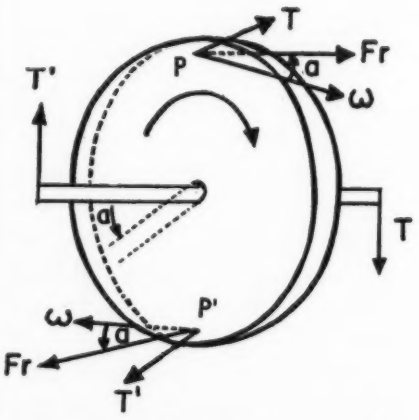


FIG. 2. PRECESSION occurs when the resultant (F_r, produced by rotational velocity (ω) and the applied torque couple (T-T'), tends to rotate the gyro system about a vertical axis in the direction of angle (α).

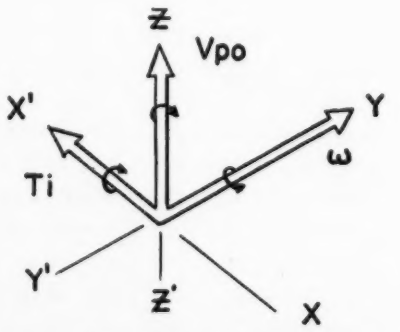


FIG. 3. VECTOR RELATIONS between rotational velocity (ω), torque input (T_i), and precessional velocity (V_{po}) are shown for normal output of positional gyro.

AN INERTIAL guidance system may be defined as one which obtains guidance information solely from gravitational effects and acceleration data relative to inertial space, and is independent of all outside sources of information.

The requirements for inertial guidance systems must always include a datum. This datum is the reference to which all corrections will be made thereby controlling the course of an aircraft or missile.

Inertial Systems

The reference frame relative to which the laws of motion take their usual form consists of a set of rigid axes fixed relative to the average position of the fixed stars. This frame is called the primary inertial system. Any set of rigid axes moving with constant velocity and without rotation constitutes a secondary inertial system. If the motion of a particle is referred to the primary inertial system, Newton's fundamental laws of dynamics are:

1. A particle remains at rest, or moves in a straight line with constant speed in the absence of external forces.

2. The resultant force acting on a particle equals in magnitude and direction the product of its mass (scalar) and its acceleration (vector).

3. If two particles exert forces on each other, the force exerted by the first on the second is equal and

By Gyros

FRANCIS J. ENGE

Program Project Mgr., Loral Electronics Corp.

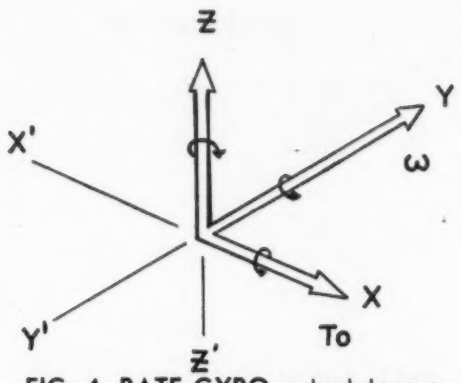


FIG. 4. RATE GYRO output torque (T_o) results from rotational velocity of gyro (ω) and input velocity of gimbal rotation (V_{rl}). $I_{yy'} > I_{xx'}$.

opposite to the force exerted by the second on the first.

A free gyro which is perfectly balanced and provided with frictionless bearings will have its spin axis directed to some point in space, and will remain fixed with respect to inertial space regardless of any motion of the vehicle carrying the free gyro, or any rotation of the earth below the vehicle. This may be proved by applying Newton's Laws of Motion which in essence state that each particle in a spinning rotor resists changes in its direction of motion with respect to inertial space. Therefore, such a spinning rotor will tend to remain in its instantaneous plane of rotation; or, its spin axis will hold its orientation with respect to inertial space.

Three spinning rotors with axes mutually perpendicular to each other and carried by gimbals each having a single degree of freedom with respect to the framework to which the gimbals are fixed, may be considered to constitute a gyroscopic secondary inertial system, which will resist rotation in any plane.

A second principle, equally important to inertial guidance, is that the direction of gravity is unique at any point on the earth's surface; namely, being toward the earth's center of gravity. Thus a gravity-sensing device, such as a pendulum which can accurately measure the vertical at the poistion of a launching pad and relate this measurement with the vertical at a target, can be used in combination with a gyro system to guide a missile (Fig. 1).

Gyroscopic Action

A gyroscope has two essential qualities which account for its usefulness in guidance systems. These are:

1. The axis of a free gyroscope will remain fixed with respect to inertial space provided no external forces act upon it, and

2. A gyroscope can be made to deliver an output torque which is proportional to the angular velocity of displacement from its rotational axis.

Both these qualities result from the principle of conservation of angular momentum which states that in any system of particles, the total angular momentum of the system relative to any point fixed in space remains constant, provided no external forces act upon it. Several forces, in practice, do act upon a gyroscope and it is necessary to compensate for the reaction of the gyroscope to such forces.

Precession

If a torque is applied to the rotor axis through the gimbal structure (Fig. 2) and the rotor velocity held constant, the spin axis will turn toward the axis about which the torque is applied. If the forces acting on a particle P in the top rim of the gyro wheel are considered, the vector sum of the instantaneous velocity of the particles and the torque component which is at right angles to the rim velocity will be the resultant force F_r. Similarly, the resultant force F'_r on a particle P′ at the bottom rim of the wheel forms a couple with F_r to precess or turn the plane of rotation of the wheel through angle a into the plane determined by F'_r. If the torque is continuously applied precession will continue. Note that the direction of precession is such that it tends to align the rotation of the rotor with the direction of the applied torque, through the smaller of the two possible angles.

The angular velocity of precession is directly proportional to the magnitude of the torque, and inversely proportional to the product of the rotor's angular velocity and the moment of inertia of the rotor.

If, as in the above illustration, a torque is applied to the gimbal, the only effective component of that torque will be that at right angles to the angular momentum vector. The angular momentum vector can be represented by an arrow in line with the gyro axis and its head pointing in the direction a right hand screw would travel if driven by the rotation of the gyro. Similarly, the torque vector may be represented by a single axial arrow (Fig. 3) at right angles to the momentum vector. The cross product of these two vectors is a third vector P_{vo} which represents the angular velocity output of the gimbal about an axis at right angles to both the torque vector and the angular momentum vector.

Conversely, if an input force is applied to the gimbal to impart to it an angular input velocity V_{rl} (Fig. 4), the result is an output torque vector T_o, which is at right angles to the angular momentum vector ω_m, and also to the angular input velocity. Note that the direction of the output torque is opposite to that of the input torque in Fig. 3, and that its magnitude is proportional to the vector product of the magnitudes of the angular momentum and angular gimbal velocity.

The use of suitable transducers (potentiometers, magnetic devices, etc.) yields a voltage output proportional to the angular displacements or output torques produced by the gyro system. The voltages provide a means for recording the information thus produced or for correcting deviations to maintain a desired course.

Nutation

When actual gimbal-rotor systems are considered, angular momentum components of appreciable magnitude about axes other than the spin axis may exist for brief periods. Such disturbances can cause oscillatory nodding of the spin axis, called NUTATION. This wobbling can be considered a form of rotational resonance and can be minimized by increasing the size of the rotor and/or increasing its angular velocity to make the resultant momentum vector coincide with the spin axis. Any damping must be with respect o inertial space.

Centrifugal and Coriolis Effects

The effective acceleration of a freely falling body relative to the earth is the resultant of not only the gravitational force vector, but also of centrifugal reaction. This centrifugal reaction results in an eastward deviation, X, determined by the equation:

$$X = 1/3\ \omega g t^3\ \cos\phi$$

where ω = angular velocity of rotating earth
and ϕ = latitude

A particle moving horizontally in a straight line with respect to space moves in a curved path with respect to earth. Also any pendulous device indicating the vertical is subject to this acceleration, called the Coriolis effect. The horizontal deviating acceleration, a_h, is determined by:

$$a_h = 2\omega v \sin\phi$$

where v = horizontal velocity of particle, and ω and ϕ are as previously defined. The direction of this acceleration is always to the right in the northern hemisphere and always to the left in the southern hemisphere, regardless of the direction of flight.

The preceding discussion has indicated that gyroscopic systems must have two properties. The first is the ability of a gyroscopic system to hold fixed a reference or datum point with respect to inertial space in the presence of disturbing forces acting on the vehicle, and the second is its response (angular velocity) to orders permitting its reference to rotate with respect to inertial space. This second property permits programming the flight of a missile to compensate for drift and other errors.

FIG. 1. TRANSIENT and permanent magnistor characteristics are combined in new MPT-1 comparison device having miniature size and high reliability.

A NEW dime-sized magnetic component, designated a transient permanent magnistor, Type MPT-1 (Fig. 1), has been announced by the *Potter Instrument Co., Plainview, N. Y.* This component, originally designed to accomplish high speed comparisons between stored data and interrogating sources such as magnetic or perforated tapes, has many other possible applications for which it is recommended by its miniature size and inherent high reliability. The component is said to make possible high speed printer systems one-third smaller than those now used by the Armed Forces.

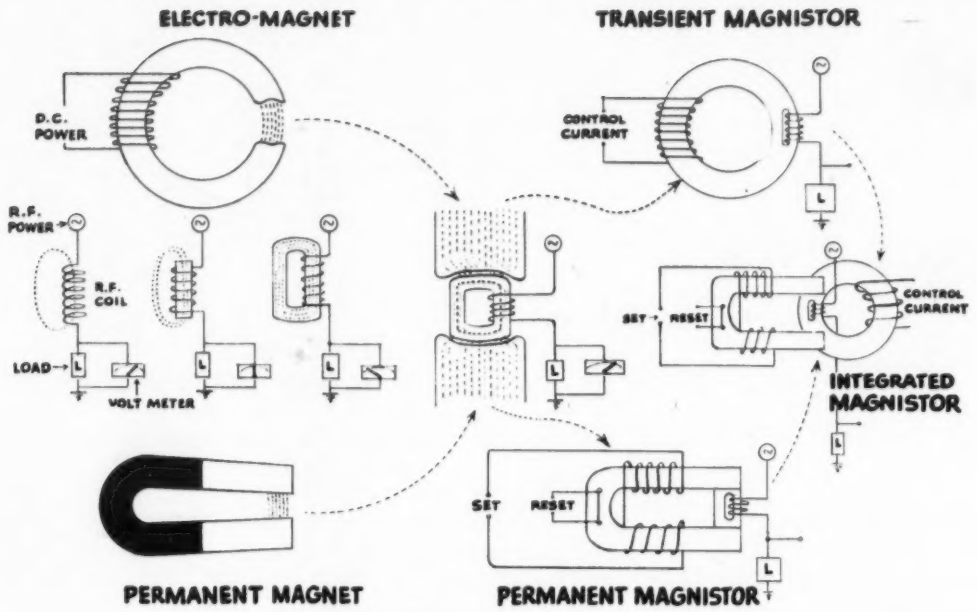


FIG. 2. EVOLUTION of Integrated Magnistor.

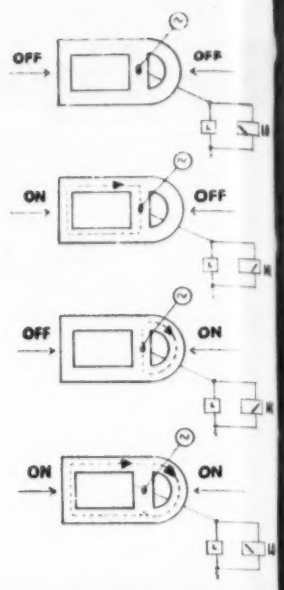


FIG. 3. INTEGRATED MAGNISTOR has four logical states.

Transient Permanent Magnistor is Miniatur

Possible applications for the new device include automatic control equipment, business data handling systems, magnetic proximity detection, magnetic tape systems, high speed printer systems, automatic volume control systems and automatic on-off switching systems for thyratrons.

The new epoxy-sealed magnistors are said to be so durable that they can be incorporated directly into data processing equipment without provision for replacement, to have an unlimited shelf life, ability to operate over a wide frequency range, and to have been proved by over three years of testing to possess near "absolute reliability."

The magnistor differs from the magnetic amplifier chiefly in its size and use of a 10 mc carrier frequency instead of the 60 or 400 cps carrier used by the magnetic amplifier.

The basic principle of operation of the MPT-1 Magnistor is the effect of magnetic saturation on the powdered iron core of an RF inductor. As shown in the series at the left, Fig. 2, an air-core RF coil imposes small reactance to an RF oscillator, allowing a large current to flow, whereas a magnetic core inserted into the coil produces a high reactance, reducing the current and the voltage drop across the series load, L. Magnetic flux, whether from an electromagnet with a core of low retentivity, or from a permanent magnet having a core of high retentivity, can be used to saturate the core of the RF inductor. Saturation returns the inductor to a low reactance state, in effect equivalent to an air-core coil. The RF current then rises, causing a high voltage drop across the load.

This suggests two types of magnistors, the transient magnistor, in which the RF current can be varied by changing the control current; and the permanent magnistor, in which a magnetic circuit of high retentivity can be "permanently" magnetized or demagnetized at will by "set" and "reset" windings; to produce an "on-off" control element.

When the transient and permanent magnistors are combined in one unit, as shown in the Integrated Magnistor, it becomes a device which can store digital information and be interrogated repeatedly by another source, yet can be instantly reset at will.

The four possible magnetic states that may exist within the MPT-1 and the corresponding relative values of RF voltage across the load are shown in Fig. 3. In the upper figure the rectangular (high retentivity) magnetic circuit and the circular (low retentivity) magnetic circuit are both in a demagnetized state; accordingly the signal winding has a high inductive value, resulting in a negligible output voltage.

In the second and third figures, magnetism from either the permanent magnet (stored information) or the transient magnet (interrogating signal) alone, saturates the signal winding core resulting in a high output voltage.

In the bottom figure, if both magnetic circuits are magnetized their fields cancel in the core of the signal coil, its impedance is high and the output voltage is low. A low output signal then means that the interrogating signal agrees with the stored signal; conversely, a high output signal means that the interrogating signal, whether a pulse or absence of a pulse, does not agree with the stored signal. When applied to a six-digit data logic circuit, as shown in Fig. 4, the failure of the stored condition of any one digit to agree with its interrogating pulse will produce a high RF current flow through the signal winding of that magnistor which will be rectified into a dc signal in the coincidence output. This circuit suggests that the reason for separate "set" and "reset" windings is for convenience in circuit arrangements; also that direct current of only one polarity is normally used to actuate set interrogation and reset windings.

The source of RF signal power is also a miniscule package—the encapsulated Q-1Y oscillator source designed for printed circuit applications. A —20 v dc

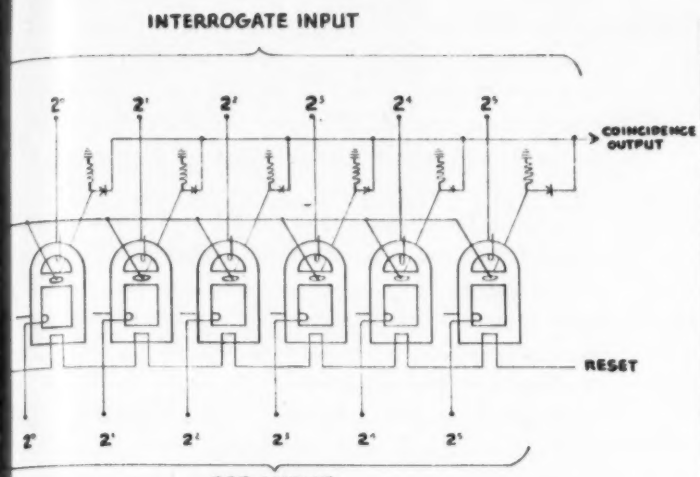


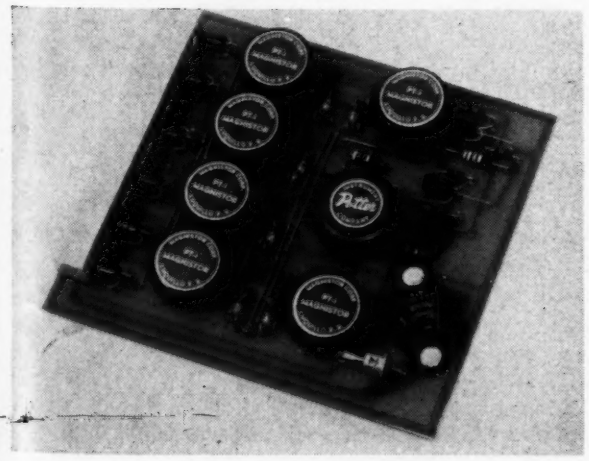
FIG. 4. **COINCIDENCE DETECTION** of Binary Coded Alpha-Numeric Characters in data Logic Circuit. Set input is energized by tape playback or computer, storing character in permanent section. Comparison code generator internal to the printer energizes the interrogate input. A fall of potential at the coincidence output indicates parity between stored and generated numbers and signals operation of the print hammer.

ur[illegible]omputer Element

input applied to this unit will produce a 10mc 2v rms output of sufficient power to accommodate more than ten Magnistors. In Fig. 5 one Q-1Y oscillator is combined with six MPT-1 units to form an alpha-numeric character module for use in the Potter High Speed Printer and Data Lister.

For more information on MPT-1 Magnistor circle **172**

FIG. 5. **ALPHA-NUMERIC** character module for use in Potter High Speed Printer and Data Lister includes six MPT-1 units with single Q-1Y oscillator to provide 10 mc carrier.



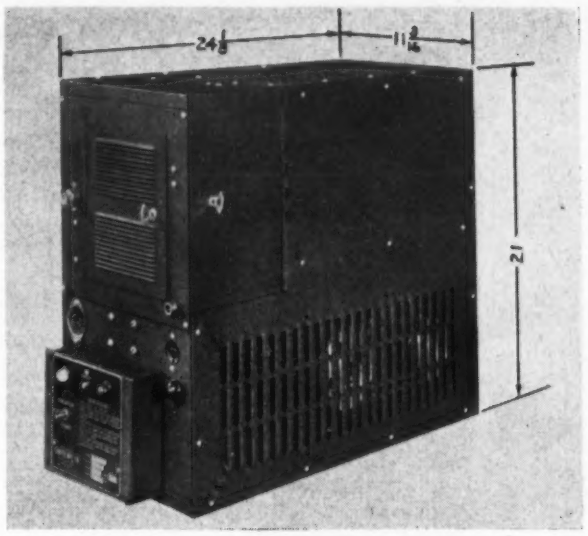


FIG. 1.

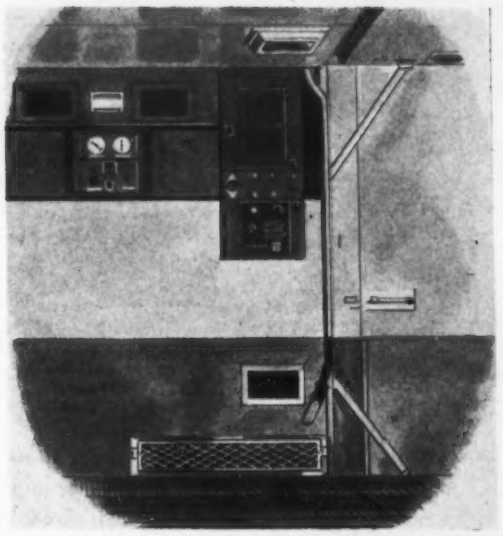


FIG. 2.

Heat For Military Shelters

ARTIC military forces, whether watchfully keeping the peace or waging a missile war, must first of all win their battle with Polar Cold. Temperatures from —40° to —65°F can freeze rubber into brittleness, immobilize machinery and render battery-powered electronic equipment lifeless. Although cold-resistant materials and lubricants have helped in the "winterizing" process, arctic military operations must primarily depend on safe, adequate heat for proper functioning of equipment, as well as for personnel.

How efficiently the heating function for military communications and reconnaissance systems is being accomplished is illustrated by the new Hunter Model UH-68 heater (Fig. 1) for mobile and portable shelters. Designed in accordance with MIL-H-11511B, this heater has been specified for use in the U. S. Engineer Corps Expansible Body program, the AN/GPQ-T1 Air Force Trainer Radar, and in modified form for communication shelters for the Matador Missile. This heater fits unobtrusively in the upper corner of a trailer (Fig. 2) to give a 60,000 BTU output on three quarts of fuel per hour. Measuring only 21″ high, 11″ deep and 24″ wide, it fan circulates heated air directly into the body, or into the shelter through ducts in the floor or through the type and kind of air transmission system desired in the end item. It weighs only 135 lbs., excluding fuel and ducts.

Any type of gasoline, JP-4 jet fuel and some fuel oils may be used as heater fuel. The ability to use high flash-point fuels is particularly important for military space heaters, because aviation gas is frequently the only fuel available. Thermostatically controlled blowers circulate the heated air into the vehicle. Controls are incorporated in the heater to recirculate air or to introduce outside air as desired. 500 cubic feet of air per minute at 0.2″ water column differential pressure can be warmed 140°F at full capacity.

The Engineer Corps Expansible Van uses two Model UH-68 heaters (Fig. 3) installed over the cab. The two stainless steel exhausts seen at the front discharge the products of combustion outside and above the cab. Operation of the heating system is essentially automatic, with temperature control thermostats, solenoid control valves and overheat switches to make its functioning foolproof.

The equipment can start from a —65°F condition with an electrical consumption of 400 watts to operate the fuel blower and the glow-plug igniter. When operating in full capacity the electrical consumption is 800 watts, 115 v 60 cps. Systems engineered for 400 cps or dc power are also available. (*Additional space heater models for military use are also described in a six-page folder available on request from the Hunter Mfg. Co., 30545 Aurora Rd., Solon, Ohio*)

For this literature circle **42** on inquiry card.

FIG. 3.

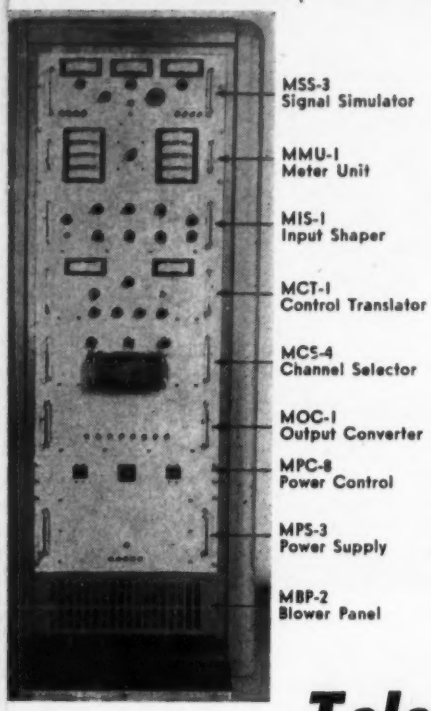


FIG. 1. BASIC M-Series PAM/PWM decommunication rack with optional meter unit and signal simulator.

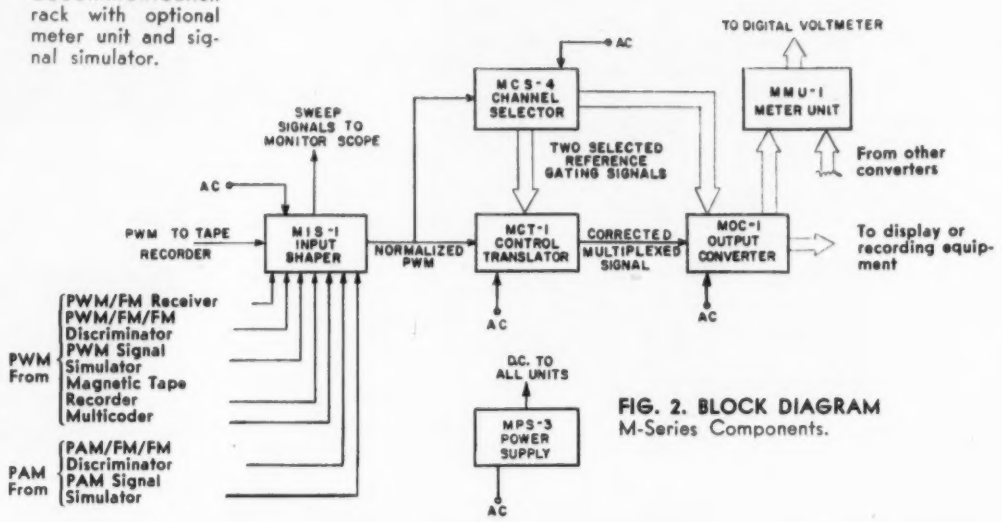


FIG. 2. BLOCK DIAGRAM M-Series Components.

Telemetering Decommutator Accepts Both PWM and PAM Signals

NEW ASCOP PAM/PWM ground station equipment (Fig. 1) differs from earlier M-Series station designs not only in its acceptance of both pulse amplitude and pulse width coding but in its ability to handle sampling rates from 23 to 3600 pps, new modular component and circuitry design, improved automatic sequence correction and synchronization, and overall long-term system accuracy of 0.5%. Connections between the various chassis of the basic unit are shown in the block diagram, Fig. 2.

The input shaper MIS-1 chassis accepts and converts PAM signals to PWM signals, which are then handled as PWM to take advantage of noise immunity, and independence of gain drifts. It also accepts PWM signals from any source and subjects them to the unique ASCOP slicing and clean-signal reconstruction processes, said to insure proper equipment operation under adverse signal conditions. The input shaper chassis also generates sweep signals for driving a bar graph monitor oscilloscope display.

The detected input signal first passes through the stage marked "shaper". Other than being a convenient signal source selector with impedance and level matching, this circuit is basically a slicer.

A thin slice is taken out of the waveform at the half-amplitude point and amplified into a sharp rectangular wave. The only limitation on signal deterioration is that the rise time not be so long that short pulses do not reach peak amplitude. Thus in theory nearly 90 microsecond rise time can be tolerated on a pulse which started out as 90 clean microseconds. In practice, rise time is limited to about half this figure to permit inclusion of various safety factors. This slicing treatment is applied to the entire multiplex wave-form.

The Channel Selector MCS-4 accepts normalized PWM outputs from the input shaper chassis and performs automatic sequence correction and channel selection of the data train for any number of channels up to 100. It will even maintain synchronization through eight sequential missing pulses with a simultaneous change in sampling rate of −20% from nominal. An AMP programmed patchboard is mounted on the front panel for direct mixing of channels and for allocation of outputs.

Control Translator chassis MCT-1 is driven by the input shaper and channel selector to generate a multiplexed signal said to be corrected for zero and full scale factors by a patented process of constant comparison to stable reference channels. It can drive any number of output converters.

Output Converter chassis MOC-1 contains eight channels of storage gate circuitry, with allocation of channels determined by the channel gate patchboard program. Other simultaneous output channels in multiples of eight can be provided by adding more output converter modules.

Ability to handle sampling rates from 24 to 3600 pps is said to ensure compatibility not only with standard IRIG PWM and PAM rates but also with a large number of non-standard rates: important for operation with new high-speed electronic multiplexers and faster-than-real-time playback of recorded PW data. The non-standard rates are also said to accommodate outputs of new statistical data-handling devices now under development by the *Applied Science Corporation of Princeton, Princeton, N. J.*

For more information on PAM/PWM Decommutator circle **43** on inquiry card.

CLIFTON PRECISION SIZE 8 ROTARY COMPONENTS

UNCHANGED AND PROVEN

MORE THAN 30,000 SHIPPED TO CUSTOMERS OVER THE PAST THREE YEARS

3/4 ACTUAL SIZE

SERVO MOTOR	SERVO MOTOR	MOTOR GENERATOR	DC MOTOR	LINEAR TRANSFORMER	TRANSMITTER	RECEIVER	CONTROL TRANSFORMER	DIFFERENTIAL	RESOLVER
Input Power (total) 3.8 watts	Input Power (total) 5.6 watts	Generator: Input Voltage 10 v	Output Power 4.0 watts	Linearity .5%	Accuracy 7' error max.	Accuracy 30' max. error spread	Accuracy 7' error max.	Accuracy 7' error max.	Accuracy 7' error max.
Stall Torque .15 oz in min. .20 oz in nom.	Stall Torque .3 oz in min.	Output Voltage 0.13 v /1000 rpm max.	No Load Speed 20,000 rpm	Null E at EZ .015 v	Null 30 mv max.	Torque Gradient 2200 mg-mm/deg.	Null 30 mv max.	Null 30 mv max.	Null 30 mv max.
Max. Weight 29 gms.	No Load Speed 6500 rpm min.		Input Voltage 28 v DC	Phase Shift 15 deg. lead	Phase Shift 8.5 deg. lead	Input Power .54 watts	Phase Shift 8.5 deg. lead	Phase Shift 9 deg. lead	Phase Shift 11 deg. lead

LOOK TO CPPC FOR SYNCHRO PROGRESS

cppc CLIFTON PRECISION PRODUCTS CO. INC.

Clifton Heights Pennsylvania

For more information circle 11 on inquiry card.

FREED

MIL-T-27A POWER, FILAMENT, PULSE & AUDIO TRANSFORMERS

FOR IMMEDIATE DELIVERY FROM STOCK

POWER TRANSFORMERS-STANDARD
All primaries 105/115/125 v., 60 c.p.s.

Cat. No.	Hi Volt Sec.	ct	DC Volts	DC Amps	Filament #1 Volt	Filament #1 Amp.	Filament #2 Volt	Filament #2 Amp.	MIL Case Size
MGP1	400/200	V	185	.070	6.3/5	2	6.3	3	HA
MGP2	650	V	260	.070	6.3/5	2	6.3	4	JB
MGP3	650	V	245	.150	6.3	5	5.0	3	KB
MGP4	800	V	318	.175	5.0	3	6.3	8	LB
MGP5	900	V	345	.250	5.0	3	6.3	8	MB
MGP6	700	V	255	.250					KB
MGP7	1100	V	419	.250					LB
MGP8	1600	V	640	.250					NB

FILAMENT TRANSFORMERS-STANDARD
All primaries 105/115/125 v., 60 c.p.s.

Cat. No.	Secondary Volt	Secondary Amp	Test VRMS	MIL Case
MGF1	2.5	3.0	2,500	EB
MGF2	2.5	10.0	2,500	GB
MGF3	5.0	3.0	2,500	FB
MGF4	5.0	10.0	2,500	HB
MGF5	6.3	2.0	2,500	FB
MGF6	6.3	5.0	2,500	GB
MGF7	6.3	10.0	2,500	JB
MGF8	6.3	20.0	2,500	KB
MGF9	2.5	10.0	10,000	JB
MGF10	5.0	10.0	10,000	KB

PULSE TRANSFORMERS

Cat. No.	Block'g. Osc.	Int. Coupl'g	Low. Pow. Out.	Pulse Voltage Kilovolts	Pulse Duration Microseconds	Duty Rate	No. of Wdgs.	Test Volt. KVRMS	Char. Imp. Ohms
MPT1	V	V		0.25/0.25/0.25	0.2-1.0	.004	3	0.7	250
MPT2	V	V		0.25/0.25	0.2-1.0	.004	2	0.7	250
MPT3	V	V		0.5/0.5/0.5	0.2-1.5	.002	3	1.0	250
MPT4	V	V		0.5/0.5	0.2-1.5	.002	2	1.0	250
MPT5	V	V		0.5/0.5/0.5	0.5-2.0	.002	3	1.0	500
MPT6	V	V		0.5/0.5	0.5-2.0	.002	2	1.0	500
MPT7	V	V	V	0.7/0.7/0.7	0.5-1.5	.002	3	1.5	200
MPT8	V	V	V	0.7/0.7	0.5-1.5	.002	2	1.5	200
MPT9	V	V	V	1.0/1.0/1.0	0.7-3.5	.002	3	2.0	200
MPT10	V	V	V	1.0/1.0	0.7-3.5	.002	2	2.0	200
MPT11	V	V	V	1.0/1.0/1.0	1.0-5.0	.002	3	2.0	500
MPT12	V	V	V	0.15/0.15/0.3/0.3	0.2-1.0	.004	4	0.7	700

AUDIO TRANSFORMERS
Freqs. resp. 300 to 10000 cps ± 2 DB. All Case Sizes Al

Catalog No.	Application	Impedance Prim. Ohms	Ct.	Sec. Ohms	Ct.	DC Current Prim. P. Side MA Max. Unbal MA	Max. Level DBM
MGA1	Single or P.P. Plates — to Single or P.P. Grids	10K	V	90K Split	V	10 10	+15
MGA2	Line to Voice Coil	600 Split		4, 8, 16		0 0	+33
MGA3	Line to Single or P.P. Grids	600 Split		135K	V	0 0	+15
MGA4	Line to Line	600 Split		600 Split		0 0	+15
MGA5	Single Plate to Line	7.6K 4.8T		600 Split		40 40	+33
MGA6	Single Plate to Voice Coil	7.0K 4.8T		4, 8, 16		40 40	+33
MGA7	Single or P.P. Plates to Line	15K	V	600 Split		10 10	+33
MGA8	P.P. Plates to Line	24K	V	600 Split		10 1	+30
MGA9	P.P. Plates to Line	60K	V	600 Split		10 1	+27

Write for further information on these units, or special designs. Send for NEW 48 page catalog. Also ask for complete Laboratory Test Instrument Catalog.

FREED TRANSFORMER CO., INC.
1793 Weirfield Street
Brooklyn (Ridgewood) 27, New York

For more information circle **12** on inquiry card.

Transistorized Frequency Standard

A new Tuning Fork Transistorized Frequency Standard, American Time Products, Inc., Type 2007-6 Series, has been developed for the frequency control of airborne and missile power supply frequencies. Accuracies to 0.005% at 400 cps are obtained from a thermostatically-controlled plug-in unit completely contained in a cylinder only 3½" high by 1½" dia.

The heart of the device is a tuning fork of bimetallic construction which makes a close approach to a zero temperature coefficient even when temperature control is not employed. The drive and pickup systems are both electromagnetically applied equally to both tines of the fork. Also the fork is rendered immune to altitude or barometric changes by hermetically sealing the assembly in a partially evacuated housing. Units without temperature control can be supplied to hold an accuracy of 0.02% over a temperature range of —65° to 125°C.

The operating "Q" of the fork is over 5000 with a choice of terminations to accommodate loadings of 75, 300, 2500 or 100,000 ohms. Other impedances (within output limit of 0.5 mw) can be provided for operating into succeeding transistor stages. Input current of approximately 10 ma at 20 to 30 v dc is needed for non-heating models while up to 0.3 amp peak (0.15 amp average) is required for the temperature-controlled model.

As specialists in high-precision frequency standards, American Time Products, Inc., 580 Fifth Ave., New York 36, N. Y., also supply timing units made to order for odd frequencies required in multichannel telemetering, selective calling, etc., Transistorized tuning forks are ideally suited for control of low frequencies where high reliability, low power, small size and light weight are requirements. Detailed specifications of the 2007-6 Series are given in a 4-page technical bulletin, available from the manufacturer.

For this literature circle **44** on inquiry card.

Small-Quantity Supply for Mil-Spec Cables

A New York manufacturer of standard electrical wires and cables has inaugurated a new service to other manufacturers producing equipment for the military. Highly specialized cables, particularly flexible and extra-flexible types, are often required in relatively small amounts. However, prime and sub-contractors frequently find that the minimum order which the mills supplying these special cables will honor is far in excess of their needs, which may be limited to from 50 to 10,000 feet.

The Saxton Products, Inc., 4320 Park Ave., Bronx 57, N. Y., is prepared to supply small-quantity orders of these special cables, as well as any amounts of their own cables listed in their catalog No. B-21. Mil-Spec Cables MIL-W-16878A &-B, -76A, -342A, -5756B, and MIL-C-3884 are in stock. Necessary certificates of compliance and source inspection are also furnished.

For catalog and cable lists circle **45** on inquiry card.

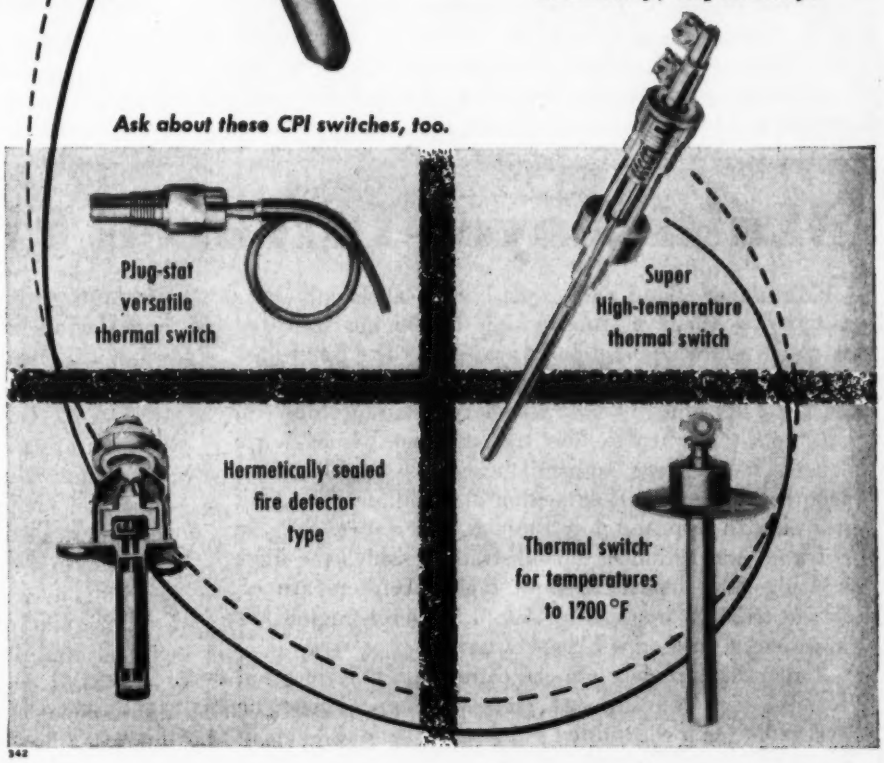
New CPI thermal switch is *Light and Lively*

This new lightweight (weighs less than one ounce) thermal switch features an operating differential of plus or minus only one degree with extremely fast response.

With an effective calibration temperature rating from —20°F +1000°F, it will even operate accurately when subjected to momentary undershoots to —80°F and overshoots to as high as 2000°F.

Wherever fast-acting, sensitive, thermally responsive regulation is required for control of dangerously high or low temperatures, this "LIGHT and LIVELY" switch will do the job accurately, dependably.

Ask about these CPI switches, too.


Plug-stat versatile thermal switch
Super High-temperature thermal switch
Hermetically sealed fire detector type
Thermal switch for temperatures to 1200°F

342

Ask our representative to tell you how CPI can help you solve your temperature control problem—and remember—when temperatures are high (or low) you can depend on CPI.
Write for complete engineering data.
Ask for catalog MA.

Control **products, inc.**

HARRISON, N. J.

For more information circle **13** on inquiry card.

Microfilms Simplify Engineering Drawings Management

Economical and efficient management of the millions of engineering drawings required by the Armed Services, through a well-integrated system which first reduces the original master drawings to microfilm, to be later reproduced inexpensively wherever required by the dry XeroX Copyflo method (MILITARY AUTOMATION, July-August 1957), is currently being demonstrated to visitors at the traveling Haloid XeroX Copyrama Show appearing in a number of leading cities.*

A small version of the Model 24 Copyflo Continuous Printer, which is being used by large-scale industrial users as well as the Air Force and the Navy, is being developed to extend the economies of microfilmed print management to smaller users and to decentralized operations of larger users. The new model, 1824, shown in mockup at the Copyrama Show (Fig. 1), will print the same high-quality drawings as its larger brother, but the size will be limited to a maximum 18″ x 24″ and the microfilm aperture cards must be inserted by hand. It is scheduled for delivery in the Fall, 1959.

Visitors to the show will see the full line of equipment used to implement the new system which is saving acres of storage space and simplifying the updating and maintenance of vital engineering information. Besides the Haloid Equipment, Recordak Microfilm equipment, Filmsort aperture card mounters, IBM data processing equipment, Rol-Dex filing equipment and Multilith offset duplicators which use masters prepared by the XeroX Copyflo process will be shown.

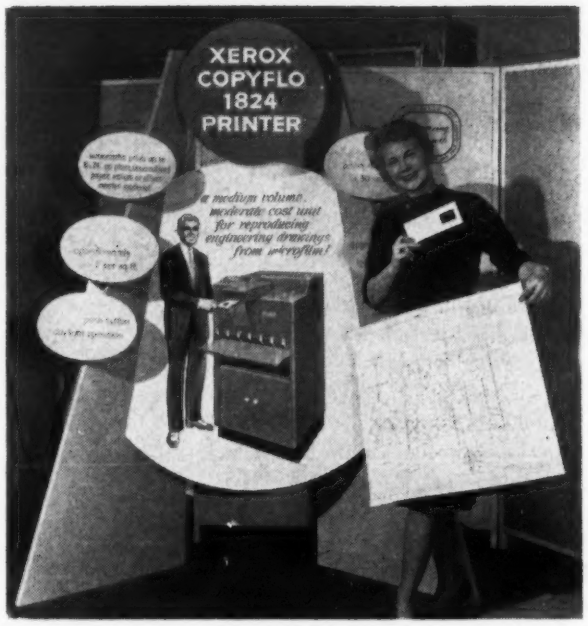


FIG. 1. NEW MODEL 1824 Copyflow printer which will enable small producers to share economies of Microfilm engineering drawing systems already in use by many government offices.

The new system achieves economies in the making, storing, filing, and mailing of large size engineering drawings by reducing the full drawing or sections of drawings to microfilm positives which are mounted on Filmsort aperture cards. The aperture cards are punched for machine sorting and also identified with plain-language labels. Duplicate aperture cards may be quickly reproduced by an automatic dry Filmsort process, enabling rapid dissemination of manufacturing and specification information to many sources of supply in any national emergency.

Conventional data processing machines minimize the labor of sorting and locating needed information, and compact filing cabinets designed for aperture cards replace entire warehouses filled with inflammable blueprints and Van Dykes. Full size dry prints made in seconds on plain paper by the Copyflo machines are ready for immediate use; are so cheap that it is far more economical to destroy them after use than to provide filing accommodations for them.

*For an itinerary and other information on the Haloid Copyrama circle **46** on inquiry card.

Multi-Layer Infrared Filters

Multilayer Band-Pass and Long-Wavelength Pass filters for selective transmission in the near-infrared range are now commercially available. The Band-Pass filters transmit a band of wavelengths sharply bounded on each side by an extended region of high reflectance and hence, low transmittance. Long-Wave length Pass filters transmit radiation of all wavelengths above the cut-off region of the filter. The long wavelength transmission limit is determined by the infrared absorption of the substrate on which the filter coatings are deposited. Both types of filters are efficient transmitters in the 1.4 to 4.5 micron region but are opaque in the visible spectrum.

Calcium aluminate glasses cannot be reheated and formed like conventional glasses. Shapes must be cast from the melt, limited at present to about 80 cu in of glass. Although these glasses withstand nitric acid and Calgon[1] solutions, they are attached by distilled water and water vapor. However, satisfactory protection is afforded by evaporated coatings or chemical treatment. Coating also enhances the optical transmission of calcium aluminate glass.

Calcium Aluminate glasses can be polished by conventional methods. Since surfaces are easily stained by water, cleaning in organic solvents is recommended. Staining is less rapid in slightly acidic media such as Calgon or its equivalent (properties of typical calcium aluminate glass compared with conventional optical flint glass are shown in Table I.)

In most cases, the filters are deposited on 1″ microscope cover-glass slips of 0.13 to 0.17 mm thickness having a useful spectral range out to about 4.5 microns. Other common substrate materials are calcium fluoride, B & L IR-1 glass and B&L Type RIR12 Calcium Aluminate glass, with transmission curves shown in Fig. 20. Magnesium oxide, lithium

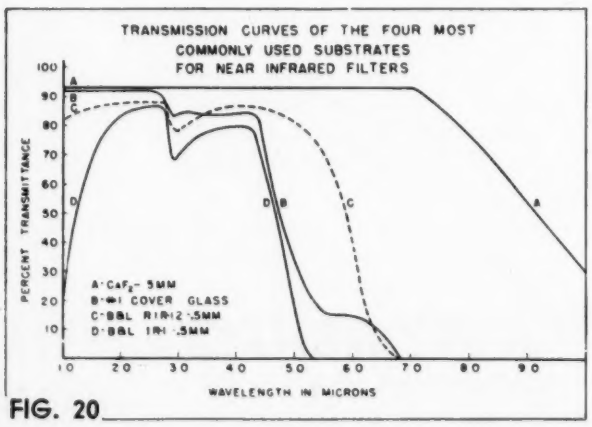


FIG. 20

TABLE 1. PROPERTIES OF A TYPICAL CALCIUM ALUMINATE GLASS COMPARED WITH CONVENTIONAL OPTICAL FLINT GLASS

Property	Optical Flint	Calcium Aluminate
Young's Modulus	7.7 x 10^6 psi	15.2 x 10^6 psi
Impact Strength	6690 psi	7490 psi
Breaking Strength CLR*	5420 psi	6500 psi
Fracture Velocity	1179 m/sec	1559 m/sec
Density	3.60	3.07
Coeff. of Expansion	8.9 x 10^{-6}/°C	8.1 x 10^{-6}/°C
Knoop Hardness	359	594
Dielectric Constant (10.21 mm thick)	7.27	9.56

*Constant Rate of Loading

[1] Tradename, Calgon Inc., Sodium hexametaphosphate.

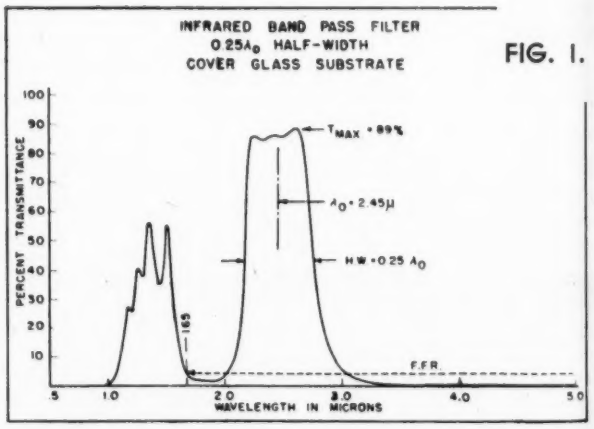


FIG. 1.

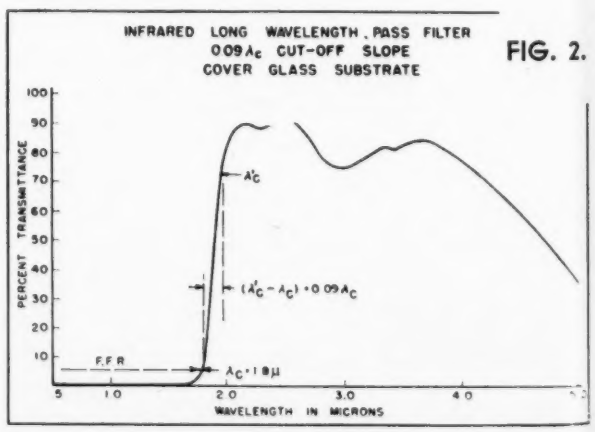
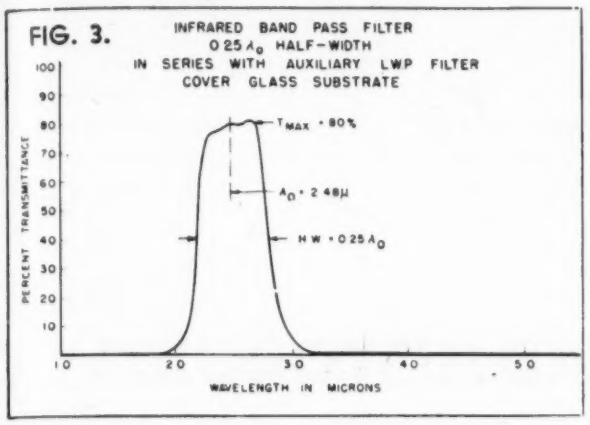


FIG. 2.

fluoride, fused quartz and other substrates may be coated satisfactorily.

Two filters can be combined on opposite sides of the same substrate to minimize substrate absorption or for convenience in use. The effect of combining a band-pass filter (Fig. 1) with a long wavelength pass filter (Fig. 2) is shown in Fig. 3.



(From Technical Progress Reports on Infrared, Bausch & Lomb Optical Co., Rochester 2, N. Y.)

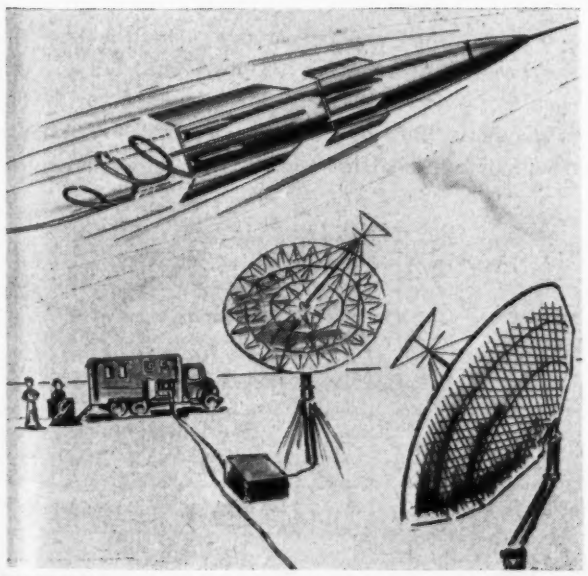
For Technical Bulletins on IR filters circle **47**
For Technical Bulletins on calcium aluminate glass circle **48**

Missile Tether

Adequate data needed by development engineers on the performance of vital missile and rocket equipment during the first few seconds following "countdown zero" could only be transmitted by wire—but ordinary cable conductors snapped and cables cracked under the impact of high velocity launchings with thrusts to 1000 ft/sec; under inertia loads to 800 G's!

Stretch Wire Corporation, of New Rochelle, N. Y., met the requirements with their SWA-4 four-conductor cable, designed for requirements of 50 watts or less. One pound of this nylon jacketed cable, having a relaxed length of 82 ft. can be stretched over 200% and return. The missile test application subjects the wire to only a single extension, a considerably different requirement from the customary uses for Stretch cables, in which the individual conductors stand more than a half-million test cycles without breakdown. Complete data are available on request on electrical characteristics of the SWA series cables.

For this literature circle **49** on inquiry card.



ARTIST'S concept of data transmission from missile via cable.

Wire for High Temperatures

The demand for increasingly higher temperature-resistant insulations has been constant. A few years ago 200°F was considered a high temperature insulation. Within a short time this became 300°F and was almost immediately increased to 500°F through the use of Teflon. With the advent of atomic energy and the missile industry the demand increased to 750°F. To meet this demand the Research and Development department of Hitemp Wires, Inc., developed "Ceramatemp," a flexible ceramic type of insulated wire for continuous operation at 1000°F.

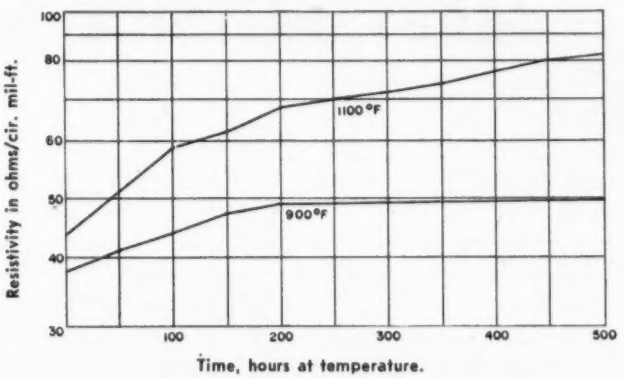


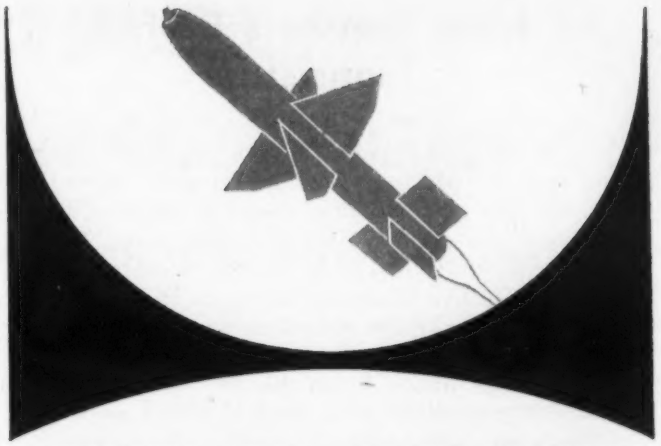
FIG. 1. RESISTIVITY OF COPPER-CLAD CONDUCTOR in Ceramatemp wire shows slow increase at 1100°F, levels off to almost constant value after 200 hrs at 900°F.

Ceramatemp is a nickel-clad copper conductor insulated with a flexible vitreous type enamel which differs from a true ceramic in that it is flexible enough to withstand wrapping round a mandrel five times the diameter of the wire. Ceramatemp insulation will not burn when subjected to a flame. At 2000°F or more, it starts to melt but does not burn.

Operation at continued elevated temperatures tends to increase the resistivity of the wire as shown in the accompanying graph. However, this increase is considerably less than for pure copper and at 900°F becomes essentially constant after the first 200 hours.

Because of its great resistance to heat and abrasion, specially designed wire strippers are needed when making connections. Also, the insulation, impervious to solvents, oils, thinners and water, can be loosened by immersing in melted sodium hydroxide (approx 800°F) followed by quenching in water, after which it can be wiped off the wire. It is being widely used for magnet and coil winding and for ultra high temperature lead wires.—(*From 8-page technical bulletin, Hitemp Wires, Inc., 1200 Shames Drive, Westbury, N. Y.*)

For this literature circle **50** on inquiry card.



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New Breakers Protect Transistors

New Type CCPG Circuit Protectors designed to protect transistor circuits at low currents and voltages, are equipped with gold-platinum contacts. Other CCP models use cadmium silver contacts. All models are available in a variety of lag variations, from *Slow lag* for normal motor overload circuits, *Medium lag* for limited inductive or capacitive surges, and *Instantaneous trip* (Fig. 1) for circuits where no time lag is needed. Using either thermal or magnetic overload elements, the device is suitable for operation at all ambient temperatures from 67°F to 131°F.

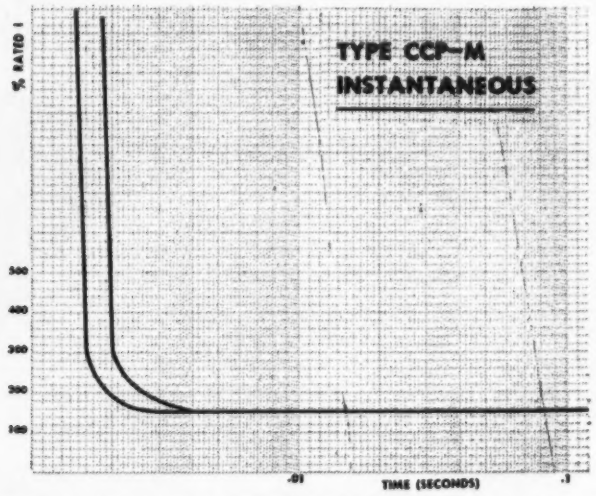
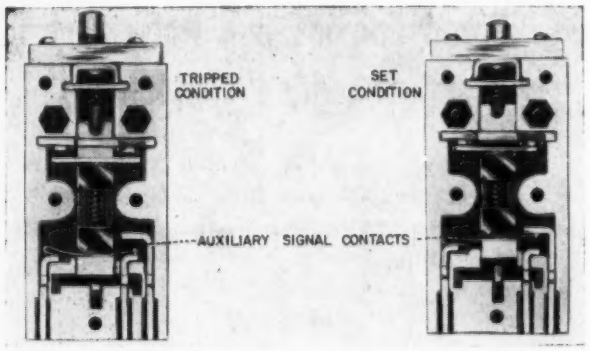


FIG. 1. RELIABLE PROTECTION of semiconductor circuits of low current capacity results from 2 msec trip time at 10 times full load current.

FIG. 2. TRIPPED (left) and untripped views of CCP circuit protector. Red band on reset button or signal from auxiliary contacts announces tripped condition.



CCP's provide both visual and electrical indication of interruption. On a trip, a red sleeve on the reset button pops up as a visual indicator. Auxiliary SPDT contacts for electrical indication are also shown in Fig. 2. CCP Circuit Protectors can be mounted side by side on a plate drilled for 1″ center-to-center mounting.

Available in ratings from 0.25 to 20 amp ac or dc, with interrupting capacities to 10 times full load current, the CCP Circuit Protector is a development of *The Rowan Controller Co.*, 2313-15 *Homewood Ave., Baltimore* 18, *Md.* A 4-page illustrated technical brochure is available on request.

For this literature circle **51** on inquiry card.

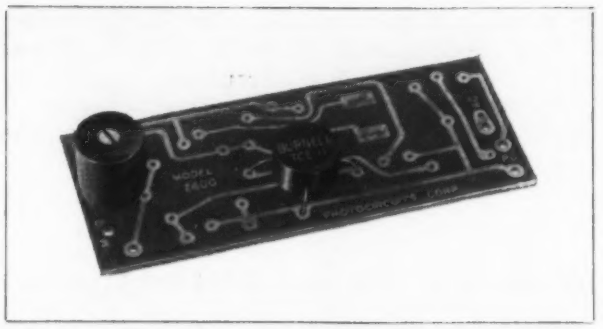


FIG. 1. SUBMINIATURE ADJUSTOROID at left end of printed circuit module provides miniaturized inductance at audio or radio frequencies.

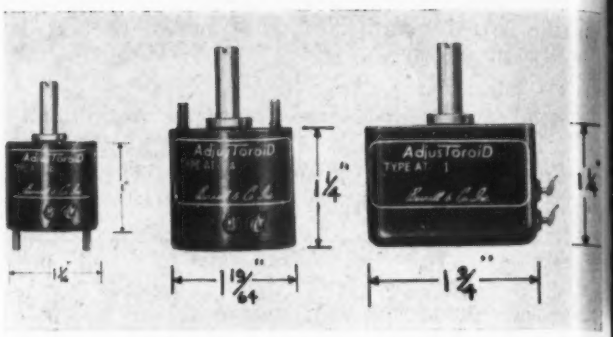


FIG. 2. "POT" MOUNTING ADJUSTOROIDS facilitate adjustment wherever slotted controls are difficult to reach. Stud mounting types give highest mounting strength for rugged missile environments.

POT-MOUNTING ADJUSTOROIDS MEET MISSILE SYSTEM DEMANDS

As smaller components are designed in response to demands for more and more equipment in less space, accessibility as well as performance and reliability become significant considerations. A complete line of encapsulated and subminiature toroids, as well as encapsulated Adjustoroids* is available to meet this need. Wherever a smaller package is desired, these components provide more unit surface economy on printed circuit boards (Fig. 1).

Latest Adjustoroid developments are the "pot" mounting types for panel mounting and knob adjustment wherever slotted controls are difficult to reach (Fig. 2). Another recent achievement, a stud mounting printed circuit type sub-miniature Adjustoroid for greater durability in high acceleration, shock and vibration environments is also portrayed.

*Registered trade name (Pat. #2;762,020) of Burnell & Co., who also supply toroids, filters, and related networks.

Adjusts To Needed Value

Burnell encapsulated Adjustoroids—subminiature encapsulated variable toroids—are equivalent in electrical specifications to Burnell type AT-11 and AT-12 Adjustoroids. The cut-away sketch of a Burnell variable inductor (Fig. 3) shows how it can be set to the exact value needed—after it is connected in the circuit.

It is continuously variable over a ten per cent range of the inductance. Inductance is varied by bucking out flux lines in the toroidal core with a field from two permanent magnets. There is no physical contact between the adjusting screw and the toroid itself.

When the north pole of the rotating magnet is directly over the fixed magnet's south pole, flux lines from the magnet are perpendicular to the core and have practically no effect on inductance (Fig. 3-B). When like poles of the permanent magnets are in line, the magnetic lines of flux repel each other and pass through the core of the toroid. Inductance is reduced

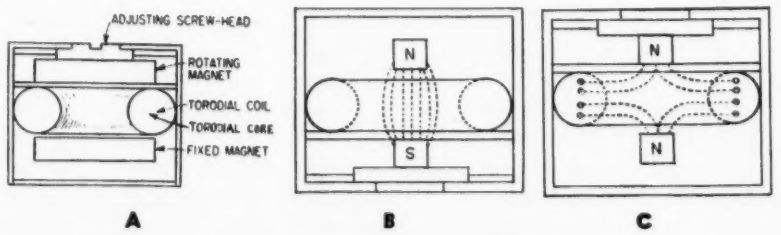


FIG. 3. INDUCTANCE VARIATION PRINCIPLE. (A) Fixed and rotating magnets are external to toroid. (B) Lines of force between unlike magnet poles pass through minimum of core material, inductance is maximum. (C) Lines of force from opposing North poles must thread toroid core to reach south poles, saturate core to produce minimum inductance condition.

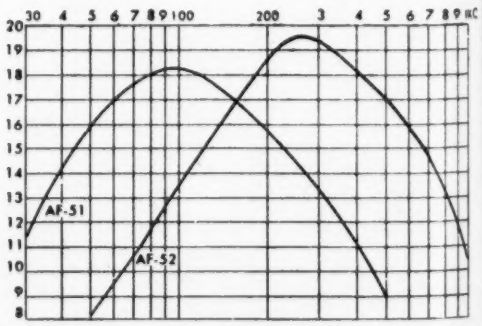
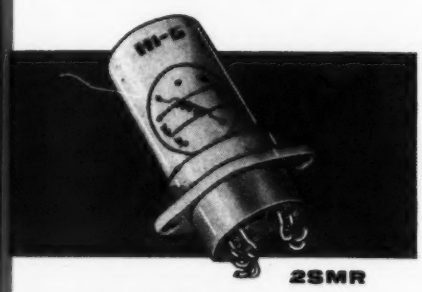


FIG. 4. HIGH FREQUENCY ADJUSTAROID Q-vs-frequency curves.

RELIABLE AND RUGGED Hi-G relays

HG-2SM
HG-2SMP

CONTACTS
1 or 2 pole, Form A, B, or C
CONTACT CURRENT
Dry circuit to 5A resistive or 3A inductive
CONTACT VOLTAGE
Up to 250 V, depending on current
COIL VOLTAGE
6 to 115 V DC
COIL RESISTANCE
Up to 5,000 ohm
SENSITIVITY (MAX)
200 mw
TEMPERATURE RANGE
—65°C to +125°C, Std.
to +150°C or +200°C, Special
SHOCK-OPERATING 100 G
NON-OPERATING 1000 G
VIBRATION
5 — 2000 cps @ 20 G
WILL EXCEED REQUIREMENTS OF:
MIL-R-5757C — MIL-R-25018



2SMR

HG-2SMR
HG-2SMRP

CONTACTS
1 or 2 pole, Form A, B, or C
CONTACT CURRENT
Dry circuit to 5A resistive or 3A inductive
CONTACT VOLTAGE
Up to 250 V, depending on current
COIL VOLTAGE
6 to 115V 60 cps or 6 to 200V 400 cps
COIL RESISTANCE
Up to 5,000 ohm
SENSITIVITY (MAX)
200 mw
TEMPERATURE RANGE
—65°C to +125°C, Std.
to +150°C, Special
SHOCK-OPERATING 100 G
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VIBRATION
5 — 2000 cps @ 20 G
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to the extent that lines of flux from the permanent magnet cancel out flux in the core itself (Fig. 3-C).

Variable Magnetic Bias

The Adjustoroid contains an actual complete toroid with all the excellent characteristics of the non-adjustable types, including high Q, low change in inductance with dc current variation, temperature stability and freedom from external field effects. Adjustment is obtained by a completely stepless function with magnetic biasing. The nominal inductance value with a tolerance of ± 2% is the maximum value for an Adjustoroid.

TABLE I—ADJUSTOROID DATA

	Length/ Dia.	Width	Hgt.	Wt.	Useful Freq. Range	Max Q	Max L in hys
AT-0	1 1/16		1"	2 oz	1 kc to 20 kc	10 kc	3 hys
AT-1	1 3/4	1 3/4	1 1/4"	7.25 oz	2 kc to 10 kc	4 kc	15 hys
AT-2	2 3/4	2 3/4	2 1/4"	24 oz	Below 2.5 kc	2.5 kc	125 hys
AT-4	1 15/64		1 1/4"	4 oz	1 kc to 16 kc	6 kc	15 hys
AT-6	1 1/16		1"	2 oz	10 kc to 100 kc	30 kc	.75 hys
AT-10	1 15/64		1 1/4"	4 oz	3 kc to 50 kc	20 kc	.75 hys
*AT-11	45/64	45/64	3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
*AT-12	45/64	45/64	3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys
AT-15	1 31/32		1 7/8"	14 oz	Below 5 kc	4 kc	125 hys
AF-51	1 15/64		2"	5 oz	30 cps to 500 cps	120 cps	1000 hys
AF-52	1 15/64		2"	5 oz	50 cps to 1 kc	250 cps	1000 hys
*AF-87	45/64	45/64	1 1/4"	1.7 oz	90 cps to 2 kc	400 cps	80 hys
*AF-88	45/64	45/64	1 1/4"	1.7 oz	.16 kc to 4 kc	800 cps	42 hys
†ATE-11	3/4		3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
†ATE-12	3/4		3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys

**Special "pot" type sub-miniature Adjustoroids are not available with AT-11, AT-12, AF-87, AF-88.*

†Special screw mountings are available with the ATE-11 and ATE-12 in printed circuit applications for "plug in" types. Where vibration and shock are significant considerations, mounting screws serve as terminal connections.

Inductance range is the nominal or maximum value minus approximately 10%. On special orders, this range has been increased to 20%. Typical Q-vs-frequency range curves for five typical high frequency Adjustoroids are shown in Fig. 4. Similarly Fig. 5 shows Q-vs-frequency characteristics for low frequency types AF-51 and AF-52. Table 1 gives other design parameters for typical members of the Burnell Adjustoroid line. Weighing approximately one half ounce, encapsulated subminiature Adjustoroids are currently in use in computers, telemetering, communication systems and guidance for such missiles as the LaCrosse, Bullpup, Polaris, Sidewinder, Falcon, Talos, Jupiter, Thor and Atlas ICBM.

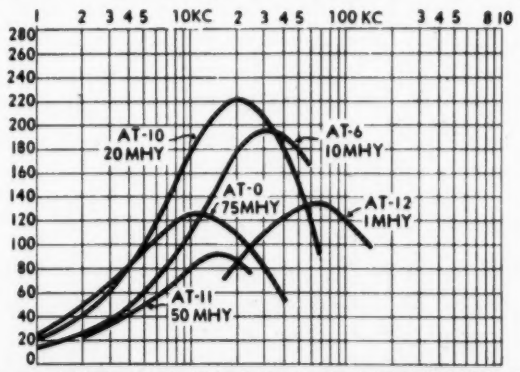

FIG. 5. AUDIO FREQUENCY ADJUSTOROID Q-vs-frequency curves.

For more information on Adjustoroids circle **52** on inquiry card.

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PLATINUM TEMPERATURE TRANSDUCERS

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- TEMPERATURES FROM —425 TO +1832 F.
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- ACCURACIES TO 0.1 F.
- 5 VOLT OUTPUT
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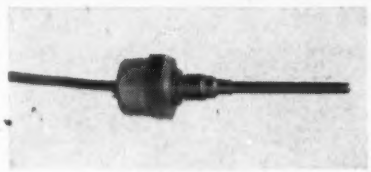
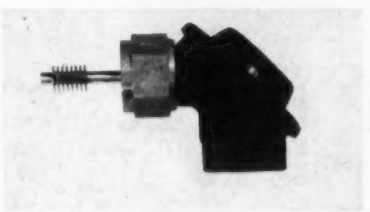


1300 Series

BULB TYPE for corrosive gases and liquids

1300 Series transducers are available in ranges from —400 F to +1832F, feature 1% accuracy, stainless-steel construction, and a time constant of less than 2.5 seconds in agitated liquid. Many standard and special bulb lengths are available.



Type 2135

Type 2135 has ±0.25 F accuracy and interchangeability over a range of 0 to +125 F. The platinum element is enclosed in a nickel-plated bulb, and the unit will withstand a working pressure of 4500 psi.

OPEN TYPE for non-corrosive gases and liquids

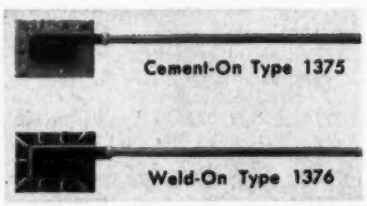
1350 Series transducers are available in ranges from —300 F to +600 F, with an accuracy of ±1% full scale. The platinum sensing element comes in direct contact with the gas or liquid being measured, resulting in a typical response time of 0.2 second in agitated liquid.

1350 Series

Type 1321

Type 1321 is designed for extreme low temperature measurements, with special calibrations to —425 F. Operating interval is 30 F in ranges up to +250 F, with ±1% accuracy. A perforated shield protects the platinum sensing element from high flow rates.

SURFACE TYPE for all kinds of surfaces



These platinum temperature transducers can be installed by a variety of methods on any surface . . . flat or curved, metallic or non-metallic. The following types are available in ranges from —400 F to +1850 F: Cement-On, Weld-On, Tape-On, Thermopaper, Sub-Surface, and Surface Transferable.

A five-point resistance-temperature calibration certificate at 0, ¼, ½, ¾, and full scale temperature is supplied with each transducer. Custom designs for all temperature transducers are available on special order with accuracies to 0.1 F. Write to Trans-Sonics, Inc., Dept. 12, Burlington, Mass. for Condensed Catalog on Platinum Temperature Transducers.

TRANS-SONICS

Precision Transducers

For more information circle **17** on inquiry card.

FIG. 1. VARIABLE GAS ORIFICE provides rugged delay element for miniature delay relays for missile and other military applications. Hermetically sealed, with delay on energizing model is shown.

Gas Orifice Used in Rugged Delay Relay

TABLE I. OPERATING SPECIFICATIONS

Nom. operating Voltage	Pick-up[1] Voltage	Drop-out[2] Voltage	Coil resistance ±10% ohms	Power Input watts
28 v dc	18 v dc	1.5 v dc	131	6.0
48 v dc	38 v dc	3.8 v dc	790	2.9
110 v dc	88 v dc	18 v dc	4945	2.6
110 v 60 cps	93 v 60 cps	55 v 60 cps	210	3.7
220 v 60 cps	185 v 60 cps	95 v 60 cps	790	4.1

Note 1. Pick-up voltage: The minimum voltage at which a unit is operable.

2. Drop-out voltage: The maximum voltage at which an energized unit becomes de-energized.

RELAYS which operate after a delay on energizing or de-energizing are frequently needed in missile, aircraft and computer electronic systems. Instant re-cycling and freedom from voltage variations and other environmental conditions are also usually specified by the system parameters.

These requirements are met by the new Agastat miniature time delay relay depending for its reliable delay characteristics on the bleeding of a gas through a variable orifice, and now available in a wide range of timing ranges, operating voltages, and contact arrangements. Delays ranging from 0.030 seconds upward to 120 seconds are provided in four overlapping ranges.

Relays in the 2112 series (Fig. 1) operate following the set delay when a pickup voltage (18 to 30 v dc for the nominal 28 v unit) is impressed on the operating solenoid. At the expiration of the delay period the normally closed contacts open and the normally open contacts close. Contacts remain in this operated position until the relay is de-energized at which time the contacts instantaneously return to their normal position. Contact arrangements available in the 2112 Series are shown in Fig. 2. Contact capacity is rated at 10 amp resistive at 30 v dc, 1 amp at 110 v dc, 3 amp at 110 v 60 cps and 1.5 amp at 220 v 60 cps.

Recycling can occur within 20 milliseconds after the coil is deenergized, either during or after expiration of the time delay. If current to the operating coil is interrupted before expiration of the delay, no operation occurs.

Relays in the 2112 series (Contact arrangements shown in Fig. 3) pull-in within 20 milliseconds after pick-up voltage is applied (Table I), instantaneously transferring the normally closed contacts to the normally open contacts. Contacts will remain in this position as long as the coil is energized, plus the duration of the delay period, which begins immediately upon coil de-energization. At the end of the time delay, the contacts return to their normal unenergized position.

Re-energizing the coil either during or after expiration of the time delay immediately starts a new cycle.

Timing repeat accuracy at 70°F is within ±5% of set delay, ±7% at 160°F, and ±8% at −67°F. Vibration up to 10 G at 500 cps in accordance with MIL-E-5272A will not cause the contacts to chatter, and shocks up to 75 G are withstood, exceeding the requirements of the same specification. The relay is position-sensitive to acceleration, withstanding up to 100 G in some planes without contact opening, but withstanding at least 10 G in any axis, for the standard unit. Where particularly severe environmental standards must be met, the manufacturer should be consulted.

Hermetically sealed relays are adjustable by removing the cap nut from the top of the unit and turning the adjusting screw thus exposed clockwise to increase the time, counter-clockwise to decrease the delay. Some dust-tight models are provided with an external knob for adjusting the delay. Other dust-tight models are adjusted by removing the cover plate secured by four holding screws, which exposes a wire key which is similarly operated.

Contact arrangements for solder lugs, Octal plug or "AN" connector terminals are available, with the maximum weight for any unit, including its connector, only 15 oz. (*From 4-page technical Bulletin 5M-2, AGA Div., Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth, N. J.*)

For this literature circle **53** on inquiry card.

2112 SERIES

FIG. 2. CONTACT ARRANGEMENTS for delay-on-energizing models. Delays from 0.030 sec to 2 minutes are available in four overlapping ranges.

2122 SERIES

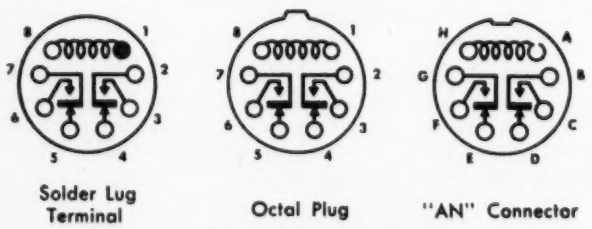
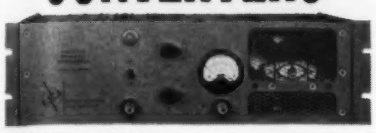


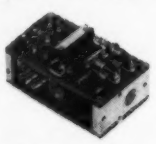
FIG. 3. CONTACT ARRANGEMENTS for delay-on-deenergizing type relays. These relays pick-up without delay (within 20 milliseconds) either during or after expiration of the time delay.

Military reliability in

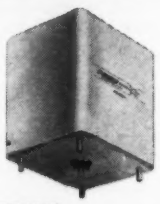
SEMI-CONDUCTOR POWER CONVERTERS



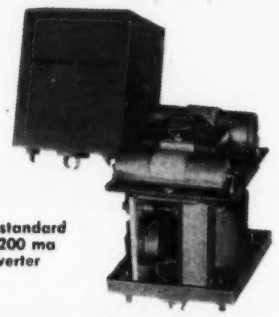
PS-4000B 115 volt AC input; 300 volt 1.5 ampere regulated DC output supply



PS-8001
300 watt miniature all-silicon rectifier regulator



PS-3001
26 volt DC input, 115 volt, 150 VA Square wave output



PS-1004B standard 325 volt, 200 ma dc-dc converter

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Complete range of sizes, types and capacities for military and commercial requirements:

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- DC to DC available in combinations of the DC to AC and AC to DC ratings shown above.
- Military Reliability is assured by extremely conservative designs and the use of the best, pretested military grade components and advanced semiconductor techniques. Meet MIL-E-5400 and MIL-E-8189.

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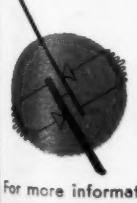

Burlington
Massachusetts

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Fitting the Servo Motor to its Job

In a servo system, the output of an error sensing device is fed, after amplification, to the control winding on the servo motor stator. This varies the electromagnetic field, thus controlling the speed and torque of the motor. The servo motor, therefore responds to the output of the error sensing device by acting to reposition the controlled object to the position indicated by the position signalling device.

Ketay Servo Motors are small induction motors designed with a high ratio of torque to inertia, capable

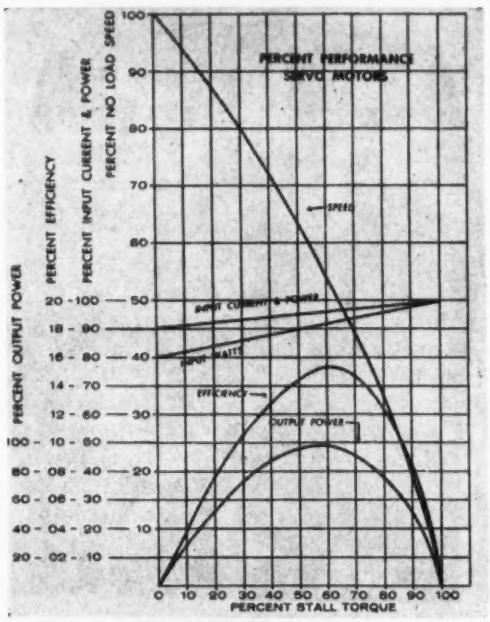
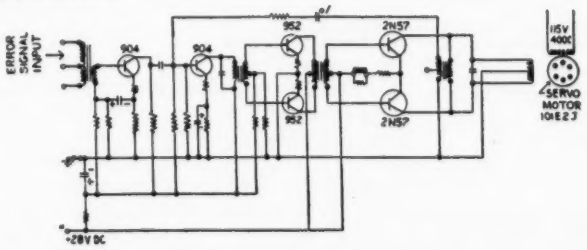


FIG. 1. CHARACTERISTICS of standard Ketay Servo Motors are shown in terms of percentages of full load values shown in tables.

FIG. 2. TRANSISTOR Servo-Amplifier Servo-Motor application.



of high acceleration, smooth performance at near stall conditions, and operation at low control voltages (Fig. 1). These motors are designed to reflect viscous damping into servo systems and to develop braking torque under single phase conditions.

A Servo Motor specifically designed for transistor circuit application, such as shown in Fig. 2, is the type 101E2J, with low input impedance control windings, center tapped. Normal voltage across this control winding is 40 v, 400 cps. Starting voltage is 3 v; stall torque, 0.60 oz-in; rotor inertia only 1.07 gm-cm².—(*From* 10-*page Servo Motor bulletin for Design Engineers, (gives characteristics of* 18 *standard servo motors) Ketay Dept., Norden Div., United Aircraft Corp., Commack L. I., N. Y.*)

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Frequency: DC to 300 Mc
50 mV to 300 V in 5 ranges
Accuracy ± 3% AC, ± 2% DC
Measures R, 50Ω to 5MΩ
Has Overload Protection
Probe Stowage in lid

MARCONI INSTRUMENTS

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For more information circle **19** on inquiry card.

ARISTO MIC-O-LITE for SHADOW FREE ILLUMINATION

The Mic-O-Lite is a small cold light ring source designed especially to produce shadow free illumination on small objects and specimens.
Housed in a doughnut type reflector which provides an aperature in its center, the Mic-O-Lite forms an ideal source for inspection, investigation, and research in the industrial and scientific fields. A variety of interchangeable lamps are available.
FOR EXPOSING PRINTED CIRCUITS, The ARISTO TRANS-LUMINATOR, equipped with Aristo U.V. 36 (3650A) grid lamps provides a COOL, EVEN, AND FAST light over its entire glass area.
Only 6 inches deep the unit is available in sizes from 12 x 12 inches square up to 32 x 36 inches. Easily installed in any printed circuit production setup, the Trans-Luminator, free of heat, glare, and dust, assures finer circuit reproductions faster and with greater working comfort.

Write for descriptive literature.

ARISTO GRID LAMP PRODUCTS INC.
65 Harbor Rd., Port Washington No., L. I., N. Y.

For more information circle **20** on inquiry card.

SPLICE DIGITAL TAPE IN 2 SECONDS

Now splice all 5 to 8 channel paper tapes as well as all ½" to 1¼" mylar or acetate base magnetic tapes perfectly IN TWO SECONDS with the miracle Presto-Splicer.

Permanent butt-weld or overlap splice lasts under all use conditions because the splice is actually electrically fused! Sticky pastes, messy cements and brushes are entirely eliminated. After splicing, tape maintains original condition — data is neither destroyed nor distorted . . . with the new information accurately inserted.

Write for illustrated Brochure.

PRESTOSEAL MANUFACTURING CORP.
37-27 33rd STREET
LONG ISLAND CITY 1, NEW YORK

Export Dept.: Reeves Equipment Corp.
10 E. 52nd Street, New York City, New York
Cable: Reevesquip, New York

For more information circle **21** on inquiry card.

New Miniature POWER OUTLETS
For Small Electrical and Electronic Units

- SMALLEST MADE
- TAKE STANDARD PLUG
- MOUNT FROM TOP OR BOTTOM OF FLAT BRACKET
- CHOICE PRE-WIRED STYLE, OR WITH SOLDERING TERMINALS
- PHENOLIC BLOCK HAS BARRIER TO PREVENT SHORTS
- AC and DC

SHOWN FULL SIZE

No. 221 (above) with soldering terminals and steel bracket with # 6 clearance mounting holes. Also No. 222 with 6-32 tapped mounting holes No. 223 (left) with 8" #14 or #16 plastic wire leads and steel bracket with #6 clearance mounting holes. Also No. 224 with 6-32 tapped mounting holes.

KULKA ELECTRIC CORP.
Manufacturers of Electrical Wiring Devices
MOUNT VERNON, N. Y.

For more information circle **22** on inquiry card.

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES

Read by Sight, Sound or Feel

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch grams
...inch ounces
...inch pounds
...foot pounds

Every manufacturer, design and production man should have this valuable data. Sent upon request.

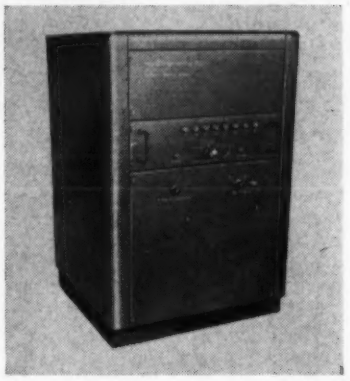
P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

For more information circle **23** on inquiry card.

SMD new products

RANDOM ACCESS MEMORY

New Model 3122 data processing random access memory, with all solid-state circuitry uses RCA standard



apertured ferrite memory plate for storage medium. Access time of 12 μsec, capacity of 512 8-binary digit characters with random access for both writing and reading, are features. No supplemental cooling is required in 650° to 105° ambients.—*Rese Engineering, Inc.*, 731 *Arch St., Philadelphia* 6, *Pa.*

For more information circle **63** on inquiry card.

NUCLEAR REACTOR INSTRUMENTATION

Nuclear instrumentation and safety equipment for power reactor measurement and control of commercial reactors based on developments used on U. S. Navy nuclear-powered ships are now available for commercial applications.—*Military Operations Dept., Allen B. DuMont Laboratories, Inc.*, 750 *Bloomfield Ave., Clifton, N. J.*

For more information circle **64** on inquiry card.

GAMMA-BETA SURVEY METER

New Model GB-1 is an improved type of portable gamma-beta log-linear radiation survey meter featuring fast response time, 0-1 mr-hr linear and two 3-decade ranges 0.5-500 mr/hr, 0.5-500 R/hr; mercury battery 300 hr continuous operation, one year intermittent; energy dependence flat to within 10% from 80 kv to 1.2 Mev.—*Riggs Nucleonics Corp.*, 717 *N. Victory Blvd., Burbank, Calif.*

For more information circle **65** on inquiry card.

PHOTOGRAPHIC DATA READER

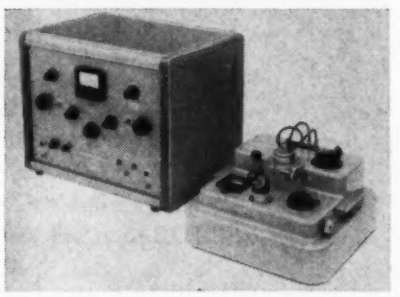
New Fairchild Data Reader for reduction of photographic analog data to digital form measures X and Y

coordinates on plates, sheet film and roll film to a least count of 0.001" and angles to 0.1°. 30x enlargement of reference cross-lines reduce eye-strain, ensures accuracy.—*Fairchild Data Devices Corp.*, 580 *Midland Ave., Yonkers, N. Y.*

For more information circle **66** on inquiry card.

POTENTIOMETER LINEARITY TESTER

New Model LT-2 linearity tester for use as an inspection gage to determine whether individual precision potentiometers meet predetermined



linearity tolerances, is also useful in locating accurately the angular position of end terminals and taps. Linearity characteristics of 1,3 and 10-turn potentiometers can be evaluated, with capability of automatic measurement after initial adjustment. Bulletin LT-2-2 sent on request.—*Boller & Chivens, Inc.*, 916 *Meridian Ave., South Pasadena, Calif.*

For more information circle **67** on inquiry card.

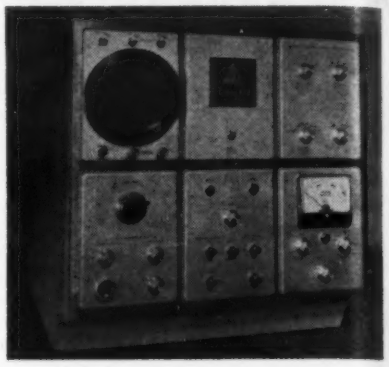
FORMS REGISTRATION BUFFER

New M-10 Registration Buffer, an auxiliary to the S-C 5000 High Speed Electronic Printer, enables the Printer to register on close tolerance preprinted forms at rates up to 5000 lines/min. This extends the field of usefulness of the computer readout system which projects alphabetical, numerical or graphical characters from the Charactron Shaped Beam Tube for dry printing on untreated paper.—*Stromberg-Carlson Div., General Dynamics Corp., Rochester* 3, *N. Y.*

For more information circle **68** on inquiry card.

NUCLEAR LAB RADIAC

New RCLiac-128 radiac instrument performs two distinct operations: (1) Counts all alpha, beta and gamma rays emitted by radioactive material;

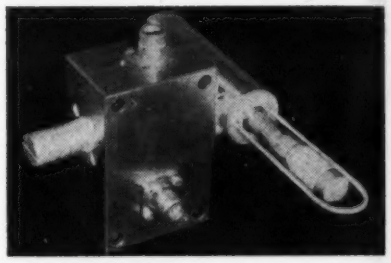


and (2) counts gamma rays and differentiates among them by determining their energy.—*Radiation Counter Labs., Inc.*, 2121 *W. Grove St., Skokie, Ill.*

For more information circle **69** on inquiry card.

COAXIAL REJECT FILTER

New 2 to 4 Kmc filter using new resonant hybrid principle, rejects any

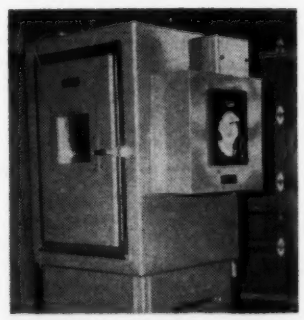


frequency in this range to the extent of 30 db with less than 1 db loss at non-resonant frequency.—*Syracuse Custom Div., Radar Design Corp., Pickard Drive, Syracuse* 11, *N. Y.*

For more information circle **70** on inquiry card.

ENVIRONMENTAL CHAMBERS

New ThermaLine series of testing chambers simulate temperatures from —150° to 400°F, high altitudes, and

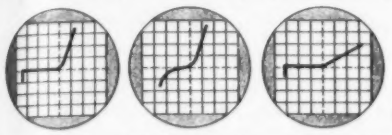


relative humidity range from 10 to 95% through 35 to 185°F. DB, and from 5 to 95% from 120°F. DB. Explosive atmospheres, dust storms and salt spray are also simulated in accordance with Mil-standard requirements.—*International Radiant Corp.*, 111 *New York Ave., Westbury, L. I., N. Y.*

For more information circle **71** on inquiry card.

SOLID-STATE RECTIFIER ANALYZER

Dynamic voltage-current characteristics of silicon, germanium and selenium power rectifiers and signal diodes are visually displayed on any

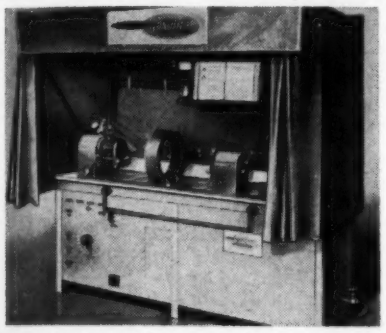


standard oscilloscope by new S-100 Series Metallic Rectifier Analyzer. Also dynamic and static reverse current-leakage and forward voltage-drop tests are read on meters, accurate to 1.0%. Described in 4-page Bulletin R-250.—*Cedco Electronics, Inc., Wilson Bldg., Camden, N. J.*

For more information circle **72** on inquiry card.

MAGNETIC INSPECTION EQUIPMENT

New Sonoflux Magnetic particle inspection equipment for crack and flaw



detection is said to provide more positive identification of defects with greater testing speed. Descriptive literature on request.—*Peterson Machine Tool, Inc., Merriam, Kansas.*

For more information circle **73** on inquiry card.

DISTANT HEAT SENSOR

New Pyrotel non-contacting heat sensor, reacting to infrared radiation of heated objects or surfaces at distances from 6" to many feet, has applications in missile, rocket and jet

plane testing and research. Standard operating range from 950° to 2000°F. but extended scales are available. Sensitivity control with repeat accuracy of ½% of scale is used to vary switching point of 5 amp load relay to temperature at which indication is desired.—*Mason Inst. Co., 29 Elm Ave., Mt. Vernon, N. Y.*

For more information circle **74** on inquiry card.

Preston Ball, left, chief of Martin reproduction department, and Parker Daggett, management engineer, compare with an original drawing the superb quality of a reduced-size copy run off from an offset paper master prepared by xerography. Original drawing was first microfilmed, then "blown back" by XeroX® Copyflo® 11 continuous printer onto a paper master for runoff on a duplicator.

thanks to *automatic* xerography...

MARTIN BALTIMORE saves $85,000 yearly

A XeroX® Copyflo® 11 continuous printer, enlarging disposable microfilm onto a continuous roll of offset paper masters, is saving Martin of Baltimore $85,000 a year in the reproduction of engineering drawings and drawing-change notices.

The Copyflo continuous printer, operating on the electrostatic principles of xerography, is completely automatic, enlarging microfilmed engineering drawings and change notices onto a continuous roll of inexpensive, offset-paper-master stock. This roll, 2,000 feet long by 12 inches wide, is then cut apart into individual masters for the runoff of multiple copies on offset duplicators.

Here are some of the advantages of the Copyflo 11 continuous printer to Martin of Baltimore:

- Annual savings of $85,000.
- Output of offset paper masters has doubled; no increase in personnel.
- Average of 20 minutes saved in engineering department on each of 50,000 yearly change notices.
- Improved quality of runoff copies.
- Specification books, training manuals, etc., now printed in half of former time, with half the paper and half the collating.

Where the copying of a few or thousands of *different* documents is needed daily, look to automatic xerography for the convincing answer. Copyflo printers enlarge, reduce, or copy same size. They offer the speediest, most flexible, most economical method to get copies precisely like the original—either from the document itself or from microfilm. For complete information, write HALOID XEROX INC., 58-209X Haloid St., Rochester 3, N. Y. Branch offices in principal U.S. and Canadian cities.

HALOID XEROX®

For more information circle **24** on inquiry card.

New Products—CONT.

MICROWAVE RELAY TESTER

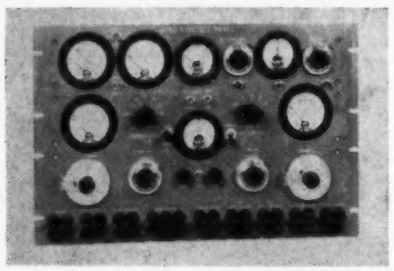
New Model 7100 microwave relay system test set, combining a signal generator, frequency meter, and power meter, tests transmitters and receivers

operating in the 5825 to 7725 mc range. Nothing else is needed in testing except an oscilloscope. Unit has 1/3-watt output, can be used as transmitter.—*Lambda-Pacific Engineering, Inc.*, 14725 *Arminta St., Van Nuys, Calif.*

For more information circle **75** on inquiry card.

GYRO TEST CONTROL PANEL

New type T856 provides automatic panel control of gyro inputs during



measurement of critical parameters. Includes all necessary switches, meters, relays and amplifiers.—*Sterling Precision Corp.*, 17 *Matinecock Ave., Port Washington, N. Y.*

For more information circle **76** on inquiry card.

ARSENIC TRISULFIDE GLASS BLANKS

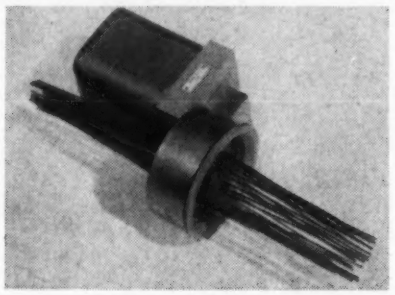
Molding of Arsenic trisulfide glass blanks in curved forms is being accomplished on a production basis.

When coated with low reflection coatings, infrared transmittances up to 96% are possible in ½" thick sheets of As_2S_3 glass in the 1 to 8 micron region of the spectrum. Said to be the only commercially available glass which covers this wide range of wavelengths, any quantity can be supplied in molded blanks, completely finished elements, or in raw bulk form.—*New Product Dept., American Optical Co., Mechanics St., Southbridge, Mass.*

For more information circle **77** on inquiry card.

WIND-TUNNEL PRESSURE CUTOFF

New PE-103 electrically operated valve cuts off 30 separate pressure lines in one position, and in the other, connects all input lines to corres-

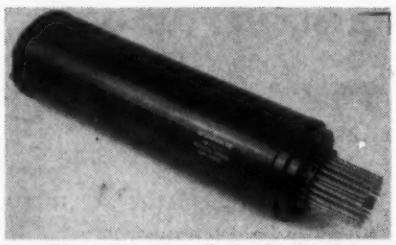


ponding outputs. Used to connect wind tunnel pressures to measuring devices, it "traps" the pressures within the measuring unit at the desired instant. Operates on 48 v dc on minimum pulse of 0.25 sec, at pressures up to 125 psig.—*Datex Corp.*, 1307 *S. Myrtle Ave., Monrovia, Calif.*

For more information circle **78** on inquiry card.

PRESSURE SAMPLING VALVE

New Type 48J high pressure sampling valve for measuring turbo-engine pressure is only 2" dia x 6.5"



long. Uses single ½" flush diaphragm transducer to scan 48 pressure inputs per second. Various motor speeds available.—*General Design*, 631- 30*th St., San Diego* 2, *Calif.*

For more information circle **79** on inquiry card.

MULTIPLEXING COMMUTATOR

New commutator design permits operation at speeds of 100 rps resulting in the same linear wear as conventional switches operating at ¼ to ½ rps. The single piece wiper is damped to prevent flutter or vibration at these rapid switching rates, and assures performance at usual speeds under conditions of severe missile shock and vibration.—*Lind Corporation, Research Park, Princeton, N. J.*

For more information circle **80** on inquiry card.

REFERENCE OSCILLATOR-MIXER

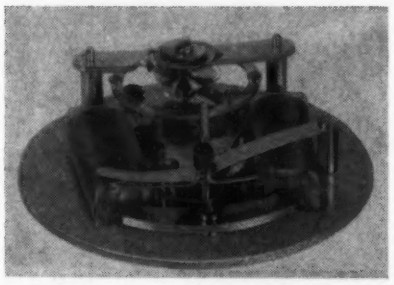
Model GRO -2 reference oscillator-mixer (1) generates a reference frequency for FM/FM telemetering mul-

tiplex, (2) mixes reference frequency and the multiplex, (3) de-emphasizes multiplex spectrum for recording, and (4) matches reference and signal amplitudes. Plug-in unit adapts to any reference frequency to 100 kc or to tape speed.—*Data-Control Systems, Inc., Danbury, Conn.*

For more information circle **81** on inquiry card.

DC PULSE TIMER

New timing movement for light military and industrial uses is available in 1.5 v to 12 v models, a single 1.5 v "C" cell giving 2 yr. operation.

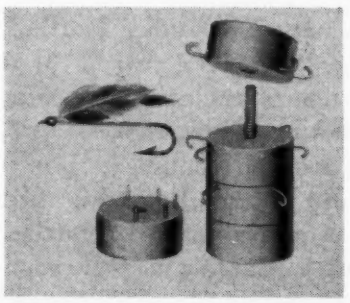


Has high shock and vibration characteristics, ± 0.01% accuracy at normal temperatures. Information on possible arrangements and applications on request.—*"Allen Products" Div., Hamilton Watch Co., Lancaster, Pa.*

For more information circle **82** on inquiry card.

TOROIDAL POWER TRANSFORMER

New 1.0 watt miniature 115 v 400 cps toroidal transformers weigh only ½ oz; have outputs from 1 to 100v



for filament supply, synchro drive, isolation, etc. Designed for printed circuits or for stacking on single screw. Meet MIL-T27A and MIL-E-5272.—*Arnold Magnetics Corp.*, 4613 *W. Jefferson Blvd., Los Angeles* 16, *Calif.*

For more information circle **83** on inquiry card.

Mass Flow Measurement in Gases

The cooling effect of moving gas on a hot wire is the principle utilized in a new mass flow measurement system used in aircraft ventilation and air conditioning measurement, and in measuring gases other than air, over temperature ranges from —65° to 175°F.

As utilized in the Trans-Sonics Type 1994 Mass Flow Transducer (Fig. 1), two platinum temperature probes extend into the air duct, the longer probe lo-

FIG. 1. TWO PLATINUM PROBES balance out ambient temperature effects in Mass Flow Transducer for aircraft applications.

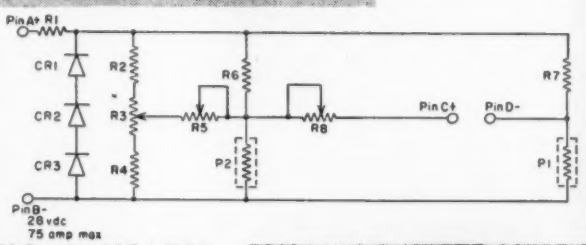


FIG. 2. HEATED PROBE, P1, forms one leg of bridge circuit of Type 1994 Mass Flow Transducer.

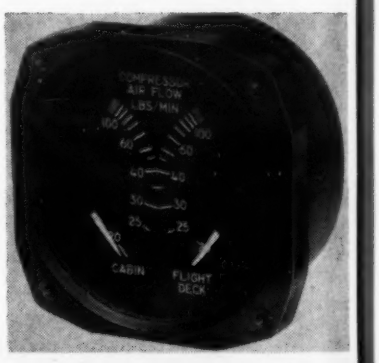


FIG. 3. DUAL INDICATOR for installation in cockpit, shows flow in two separate ducts.

cating a platinum resistance winding at the centerline of the duct. This winding (P1), Fig. 2) is heated by a relatively high steady-state current and, in accordance with well-established laws of heat transfer, makes the fundamental density-velocity measurement as it is cooled by the mass flow in the duct. Two transducers are used with a single dual indicator (Fig. 3) in typical aircraft installations.

The remaining platinum resistance winding (P2) on the shorter probe is unheated and therefore not significantly affected by mass flow. Its purpose is to compensate for changes in the output of the heated probe as a function of the ambient gas temperature. It accomplishes this by introducing a voltage which cancels out any bridge unbalance caused by the gas temperature's effect on the longer sensing probe.

Since power input into the heated probe is constant,

the rate of heat transfer is, in general, a function of the rate of mass flow. The platinum resistances in the active arms change with temperature, upsetting the bridge equilibrum and generating an unbalance signal which is proportional to the rate of mass flow. Circuit elements also include three zener diodes to provide regulation of input power.—(*From 4-page bulletin* 1994, *Trans-Sonics, Inc., Burlington, Mass.*)

For this literature circle **55** on inquiry card.

Levitation Melting Apparatus

New unique method for small-scale preparation of molten metals while suspended freely in an inert atmosphere, permits high-purity preparations of metals and alloys that are difficult to prepare by conventional methods.

In using the apparatus, (Fig. 1), the chamber is sealed, evacuated and filled to atmospheric pressure with the protective atmosphere. A prepared charge of metal, usually a compact of metal powder or chips, is removed from the specimen rack and placed within the coil by means of the manipulator.

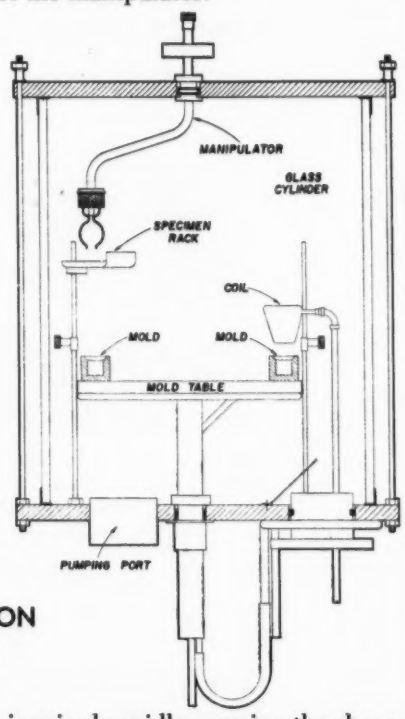


FIG. 1. LEVITATION melting chamber.

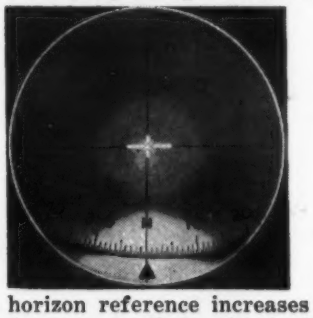
The coil voltage is raised rapidly, causing the charge to rise inside the coil and float just below the coil's top turn. Melting is accomplished usually in less than one minute, and a vigorous stirring action of the electromagnetic field assures intimate mixing of the melt. Upon completing the melt, the voltage is lowered, allowing the molten metal to pour into a thick-walled copper mold located on a movable table just below the bottom turn of the coil. As many as 15 specimens can be melted successively without opening the chamber, by use of the manipulator and the rotating mold table.

The method has also been used at the Westinghouse Research Laboratories for sintering of compacts of refractories and for holding metals in an atmosphere to study the solubility of the gas in the molten metal.—(*From 2-page leaflet of this title, Industrial Electronics Dept., Westinghouse Electric Corp., P. O. Box* 416, *Westinghouse Electric Corp., Baltimore* 3, *Md.*)

For this literature circle **56** on inquiry card.

NEW SEXTANT SYSTEM

New pendulous mirror periscopic sextant projects image of rotatable azimuth scale into field of view, also greater intensity of light in the artificial horizon reference increases opportunity to use Venus in daylight sightings. Mount also permits interchangeability with Kollsman Sky Compass for trans-Arctic operations. Available to both military and commercial users.—*Kollsman Instrument Corp.*, 80-08 45*th Ave., Elmhurst* 73, *N. Y.*



For more information circle **84** on inquiry card.

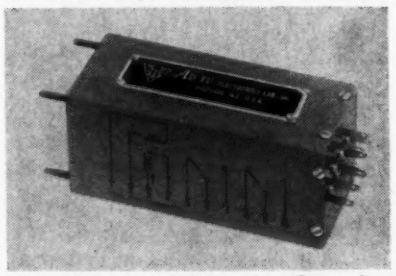
TRANSISTORIZED DELAY RELAY

New "Trans-O-Netic" relay contains transistorized control circuit with an R-C network to provide 1.5 to 30 sec delay, available in fixed adjustable type action. Control unit operates SPDT switch, providing fast switching, instantaneous reset, and reproducibility of delay period even during rapid recycling.—*Heinemann Electric Co.*, 486 *Plum St., Trenton* 2, *N. J.*

For more information circle **85** on inquiry card.

MAGNETIC AMPLIFIER RELAYS

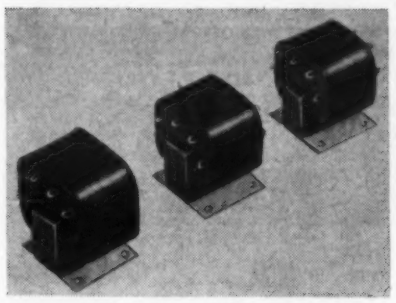
New Magnetic Amplifier relays consist of high gain magnetic amplifier loaded by a rugged relay, provides high sensitivity in the microwatt range coupled with contact ratings to 15 amp capacity. 60 and 400 cps excitation types are designed for shipboard and airborne use.—*Ad-Yu Electronics Lab., Inc.*, 249 *Terhune Ave., Passaic, N. J.*



For more information circle **86** on inquiry card.

400 CPS TRANSFORMERS

New stock 4-unit series of filament transformers for ground or airborne applications are vacuum molded to MIL-T-27 Grade 5 Specs. 105/115 v, 380/1000 cps primary; 6.3 v CT secondaries, 3 to 20 amp ratings.—*United Transformer Corp.*, 150 *Varick St., New York* 13, *N. Y.*



For more information circle **87** on inquiry card.

BEARING SMOOTHNESS METER

New Vibra-Meter measures the smooth-running quality of precision instrument bearings by analyzing axial component of disturbing forces and evaluating by an average-reading meter and three peak level trigger circuits which are set to classify bearings as good, medium or poor quality. Meter locks in for accurate reading only when bearing is rotating at 100 rpm, permitting classification by unskilled operator. Bulletin VM-1 available on request.—*Leitch-Huard Corp., Stark & Commercial Sts., Manchester, N. H.*

For more information circle **88** on inquiry card.

POTENTIOMETRIC PRESSURE TRANSDUCER

Series "T" pressure transducers for FM/FM telemetery or control systems in aircraft and missiles can be supplied with Bourdon tubes for normal or corrosive media. Pressure ranges of 0-100 psi or 0-5000 psi and temperatures up to 200°C can be handled. Linkage mass is minimum, will withstand 50% overpressure with less than 1% zero shift.—*Rahm Instruments, Westbury, N. Y.*

For more information circle **89** on inquiry card.

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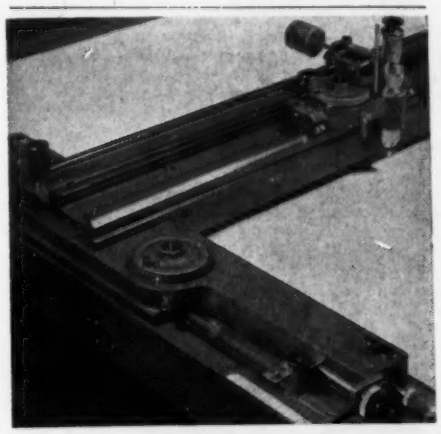
Dept. MA-11—4747 Century, Inglewood, Calif.

For more information circle **25** on inquiry card.



A BETTER PLOTTER

for Precision Layout of Grid Systems and Coordinate Positions

The Coordinatograph, a new, better plotting instrument, is now being used for all types of precision layouts. It plots within .001″ over a 47½″ x 47½″ working table. Rack and pinion construction for counter dials assures accurate measurements. 7 diameter pricker microscope permits observation and plotting in one operation. Radii from 12″ to 40″ can be plotted with beam compass. Vertically laminated plywood table. Vibration-free tripod mount. Write now for free folder.

AERO SERVICE CORPORATION

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For more information circle **26** on inquiry card.

PROTECT PRESSURE-SENSITIVE INSTRUMENTS . . . POSITIVELY

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Seals off gage or manometer connection at any pre-set pressure. Will repeat within 1% of scale. Will release 2% below cut-off point.

Models available with cutoffs from 20" water to 9000 psig. liquids and gases. Designed to withstand and hold closed against 10,000 psig.

Marine models available.

Write for Bulletin 541-G for full details and prices.

INDUSTRIAL ENGINEERING CORPORATION

525 E. Woodbine, Louisville, Ky.

For more information circle **27** on inquiry card.

BOOK REVIEWS . . .

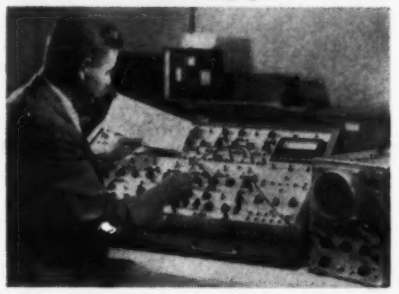
ENGLISH-RUSSIAN RUSSIAN-ENGLISH ELECTRONICS DICTIONARY, 1958, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. 943 p 6" x 9". $8.00. Prepared for Department of Army by McGraw-Hill Book Co.; translates 22,000 Russian terms to English, 25,000 terms from English into Russian.

BURGESS ENGINEERING MANUAL, 1958 edition; Burgess Battery Co., Dept. PR-1, Freeport, Ill. 100 p. 63 service life vs current drain graphs, also illustrations and dimensional drawings of batteries. 6" x 9½". Engineers engaged in design of battery-powered equipment are invited to write to the address given for their copy. Others may purchase the manual from the same source for $1.00.

New Products—CONT.

TRANSISTOR CIRCUIT SYNTHESIZER

New electronic unit enables designers to check complicated circuit designs without soldered "broadboard" construction. Metering panel includes

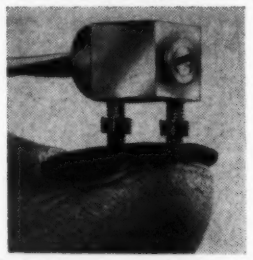


curve tracer used with external oscilloscope to display plot of collector voltage vs current. Family of curves results from variation of base current bias.—*National Electronics Labs., Sub. of Thiokol Chemical Corp.,* 1713 *Kalorama Rd., N. W., Washington, D. C.*

For more information circle **90** on inquiry card.

MICROMINIATURE TRIMMER

New ¼-inch, ¼-watt trimmer pots in horizontal stud-mounting (shown) and lead-mounting styles for printed

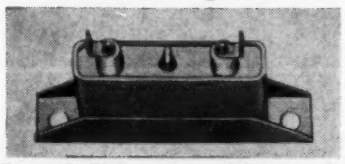


wiring boards are available in standard resistances from 100 to 10,000 ohms.—*Miniature Electronic Components Corp., Holbrook, Mass.*

For more information circle **91** on inquiry card.

HIGH TEMPERATURE CAPACITORS

New E-315 type capacitors available in sizes from 0.05 to 4.0 uf at 600 vdc are said to operate over the

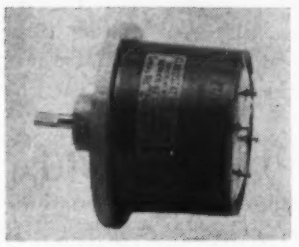


−55° to 315°C range with no voltage derating. Also features low variation in capacitance and power factor, high environmental resistance hermetic sealing, high altitude operation and rugged construction. Engineering data and operating characteristics available in Bulletin SL-61 on request.—*Scintilla Div., Bendix Aviation Corp., Sidney, N. Y.*

For more information circle **92** on inquiry card.

SINE/COSINE POTENTIOMETER

New sine/cosine pot for use in radar, computer and servomechanism assemblies have a standard conform-

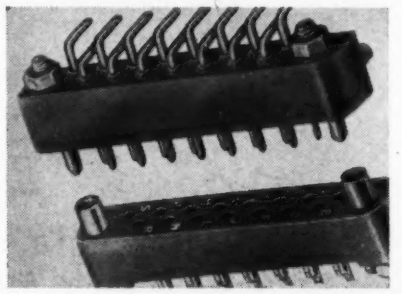


ity of ± 1% peak-to-peak or is available on special order to ± ½% conformity. 1568 turns of wire provide total resistance of 16,000 ohms ± 3%. Meets enviromental standards of MIL-E-16400A and MIL-5272 Procedure I.—*Clarostat Mfg., Co., Inc., Dover, N. H.*

For more information circle **93** on inquiry card.

PRINTED CIRCUIT CONNECTORS

New DEP Series printed circuit connectors, compatible with the 0.100 x 0.100 grid system, automatic

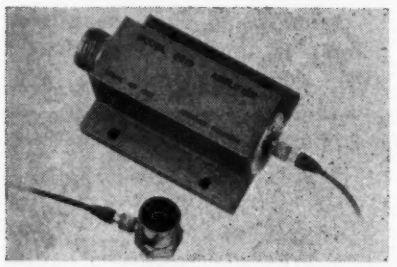


assembly and dip-soldering processes, permits either plug or receptacle or both to be board mounted. Polarized by layout and guide pins.—*Armel Electronics, Inc.,* 840 *Fifth Ave., Brooklyn* 32, *N. Y.*

For more information circle **94** on inquiry card.

ACCELEROMETER AMPLIFIER

New Model 2618 amplifier provides variable gain from 6 to 20 for use with piezoelectric accelerometers. Compensating feedback reduces dis-

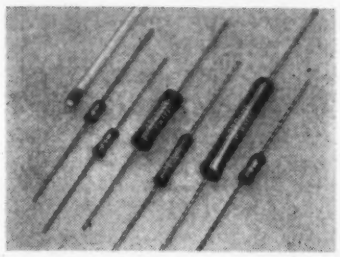


tortion to less than 1% with a gain stability of ±1%. Sealed, it operates continuously in ambients to 250°F, withstands vibration and shock to 100 G without shockmount.—*Endevco Corp.,* 161 *E. California St., Pasadena, Calif.*

For more information circle **95** on inquiry card.

MINIATURE POWER RESISTORS

New power resistors from 2 to 11 watts dissipation in smaller sizes than

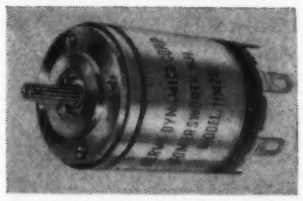


previously made are included in new Sprague Blue Jacket Resistor engineering bulletin 7410. Standard ratings in resistance tolerances of from ±1% to ±10% are available.—*Sprague Electric Co., 401 Marshall St., North Adams, Mass.*

For more information circle **96** on inquiry card.

BUORD SIZE 11 SERVOMOTOR

New Model 11M202 size 11 servomotor conforms to BuOrd spec MIL-S-17087 and MIL-E-5272A. Operating from 6 to 200 v ac, stall torque is 0.60

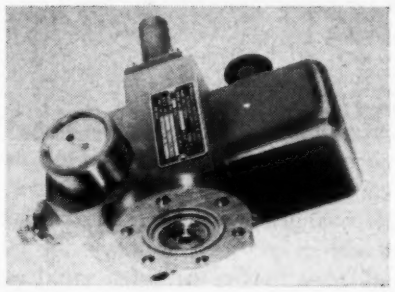


oz-in and no-load speed is 6200 rpm; at max power output torque is 0.30 oz-in, speed 3800 rpm. Designed in 60 and 400 cps models for continuous duty at stall, its operating range is from −65°C to 200°C.—*Servo Dynamics Corp., Somersworth, N. H.*

For more information circle **97** on inquiry card.

SERVO ANTICIPATES COMMAND

New integrated electro-hydraulic servo system utilizes a hydro-mechanical rate feedback which measures and feeds actuator velocity back to the servo valve flapper, providing an

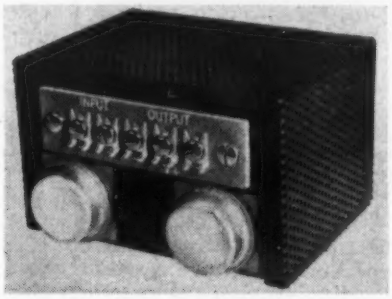


output velocity proportional to the product of the input and the time derivative of the input electrical command, thus providing velocity anticipation; is currently used for control of hot gas turbine auxiliary power unit.—*Hydraulic Research & Mfg. Co., 2835 N. Naomi St., Burbank, Calif.*

For more information circle **98** on inquiry card.

TRANSISTORIZED DC & AC PACKS

New dc-ac battery-powered units for mobile and portable receiver/transmitter operation with outputs of



330/150 v and 500/250 v, also 60 and 400 cps 100 watt inverters with 115 v square-wave outputs from 12 v input. Operate in ambients from −67° to 140°F.—Data sheet—on request.—*Kupfrian Mfg. Corp., 164 Prospect Ave., Binghamton, N. Y.*

For more information circle **99** on inquiry card.

MISSILE FREQUENCY STANDARD

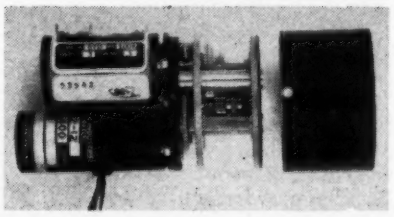
New electro-mechanical resonators holding within 0.01% accuracy in the 200-10,000 cps range without fre-

quency dividers, over −40° to 70°C temperature range and under severe shock, vibration and acceleration requirements only weigh 12 oz, can be located anywhere.—*Gyrex Corp., 3003 Pennsylvania Ave., Santa Monica, Calif.*

For more information circle **100** on inquiry card.

SERVOMECHANISM ASSEMBLY

New missile integrating servo with rate feedback consists of size 8 servo motor generator, precision potentiom-



eter and a high-ratio gear reducer. Additional information on this and custom-produced assemblies on request.—*Inst. Div., Thomas A. Edison Industries, McGraw-Edison Co., West Orange, N. J.*

For more information circle **101** on inquiry card.

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For more information circle **28** on inquiry card.

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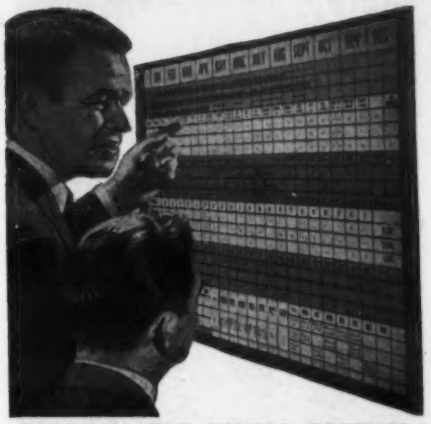

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For more information circle **29** on inquiry card.

IDL

ANALOG TO DIGITAL CONVERTERS
(GRAY, BINARY CODED DECIMAL)
1:1000; 1:3600; 1:216,000

For Missile and Airborne Applications

Speed and life . . . *with bi-directional read-out*
8,000 bits/min for 500 hours plus 2,400 bits/min for 1000 hours
20,000 bits/min for 300 hours plus 2,000 bits/min for 1700 hours

• Direct read-out at 20ma — 40V dc
• No brush lifting — no diodes — no networks
• Each code transfer point is unambiguously defined by a 9° least significant bit
• Passes MIL-E-5272B up to 100°C
• Ascending code—clockwise on shaft
• Synchro type mounting with pilots
• EVALUATION UNITS AVAILABLE WITHIN 30 DAYS

FOR SPECIFICATIONS SHOWN HERE, ORDER BY PART NUMBER

IDL Part Number	500206	500216	500217
Total number of bits	1000	3600 (0.1°)	216,000 (0.1′)
Accuracy (Resolution)	1 bit in 1000	1 bit in 3600	1 bit in 216,000
Max/Min Torque (in. oz.)	1.5/.3	1.5/.3	3.5/.3
Bits per shaft revolution	40	40	40
Weight (incl. cables)	4.7 oz.	4.8 oz.	8 oz.
Case Length	2⅜ in.	2⅜ in.	2⅜ in.
Mounting Pilot	1.754″ dia.	1.754″ dia.	2.156″ dia.

Other models available.

IDL

For prices and complete specifications write
INSTRUMENT DEVELOPMENT LABORATORIES, INC.
Subsidiary of Royal McBee Corporation
54 MECHANIC ST., ATTLEBORO, MASSACHUSETTS, U.S.A.

For more information circle **30** on inquiry card.

with Fairchild's new
400-foot capacity
high speed camera

Fairchild's high speed Motion Analysis Camera, now with a 400-foot film capacity, is especially useful for work where reloading is impractical, or where longer inspection periods are required. Here's why:

Stop-start operation at all speeds, *exclusive* in Fairchild cameras, permits multiple bursts without continuous exposure of the entire spool. The camera can be loaded in daylight with either black-and-white or color film. You can select from a series of quickly interchangeable motors providing ranges of film speeds from 10-80 pps to 800-8000 pps. Lenses from 3.7 to 152 mm. are available, in focusing mounts with bayonet lock. Weight is 24 pounds.

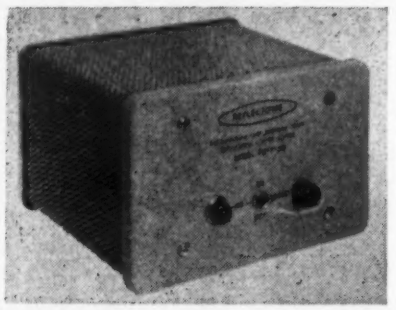
For more complete information on the HS401 Camera and its many useful accessories . . . plus the latest data on high-speed photography . . . write to Fairchild Camera & Instrument Corporation, Industrial Camera Division, Dept. 8, 5 Aerial Way, Syosset, Long Island, New York.

FAIRCHILD
CAMERA AND INSTRUMENT
CORPORATION

For more information circle **31** on inquiry card.

TRANSISTORIZED POWER SUPPLIES

General purpose model PS-T-U6 transistorized power supply has output of 6 v, 2 amps; while model PS-T-

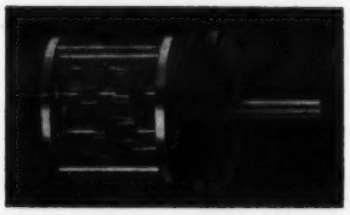


G12 provides a selectable output of 6, 12, or 18 v, 2 amps. Both models are available in bench, panel, or chassis mounting, feature 3% load regulation.—*The Reflectone Corp., Stamford, Conn.*

For more information circle **102** on inquiry card.

PRECISION GEAR HEADS

New gear heads and speed reducers said to have max backlash of 30 minutes, high torque—to-size ratio, and

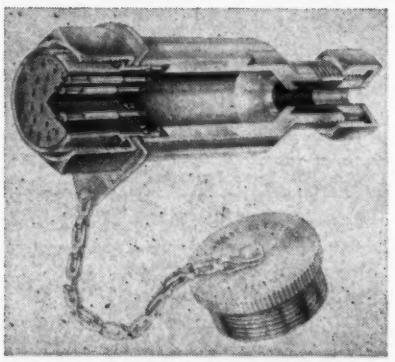


operability from −55° to 150°C, are available in sizes from 8 to 18. Prompt delivery on wide range of standard sizes is featured.—*Synchrosolve, Inc., 269 Green St., Brooklyn 22, N. Y.*

For more information circle **103** on inquiry card.

DEW-LINE WEATHER-PROOF PLUGS

New Series LR and MR all-weather connectors capable of withstanding extreme conditions of mud, ice and

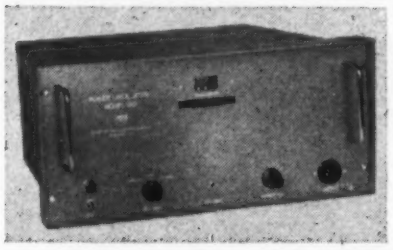


water on arctic radar systems, feature clear and black corrosion-resistant anodic coatings; built-in rubber gland for moisture sealing; and chain-attached caps.—*Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.*

For more information circle **104** on inquiry card.

VARIABLE POWER OSCILLATOR

New Model 150 Power Oscillator supplies 160 VA of power at either a fixed frequency of 400 cps ±25%

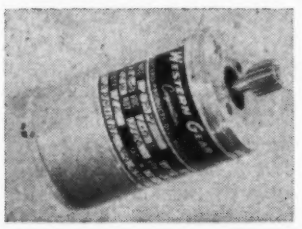


or a variable frequency with a range of 350-450 cps. Output voltage is continuously variable from 0-120 volts.—*The Industrial Test Equipment Co., 55 E. 11th St., New York, N. Y.*

For more information circle **105** on inquiry card.

MINIATURE DC MOTOR

New Model 2PP1 miniature 26.5 v dc motor is rated at 1/100 hp at



11,000 rpm. Qualifying for MIL-M-8609, it is 1.9" long, weighs only 3½ oz. Life is 500 hrs without change of brushes.—*Western Gear Corp., P. O. Box 182, Lynwood, Calif.*

For more information circle **106** on inquiry card.

CONSTANT CURRENT SOURCE

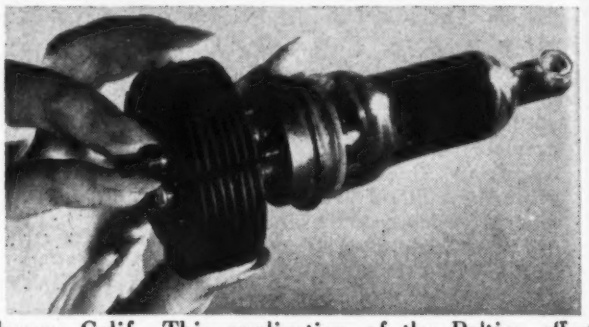
New Model 5900 constant current source for precision testing of semiconductors, thermistors, torque motors, and other current sensitive

devices delivers 1 ma to 100 ma as determined by 4-range switch and continuous vernier. Output voltage automatically changes from 0 to 100 v as determined by load resistance. Meter accuracy is ± 2% of full scale reading, load regulation is less than ¼% at any current from 1 to 100 ma. Operates on 105-125 v ac, 60 cps.—*Measurements Research Co., 3801 Castor Ave., Philadelphia 24, Pa.*

For more information circle **107** on inquiry card.

Electronic Refrigerator

A tiny electronic refrigerator capable of inducing a fifty-degree temperature drop for cooling sensitive electronic components has been developed for Navy evaluation by the Nortronics Advanced Development Dept., Nortronics Div., Northrop Aircraft, Inc., Haw-



thorne, Calif. This application of the Peltier effect produces cold by passing a current across a junction of two dissimilar metals.

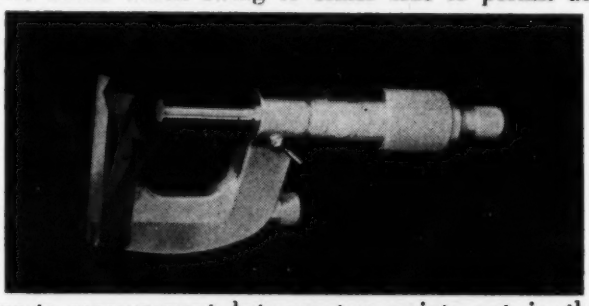
The cold junction is contained in the Dewar flask top shown in the illustration. Heat removed from this junction is dissipated by the fins shown at the lower end.

As compared to the present method of cooling infrared sensors by liquid nitrogen, the new method is expected to accomplish the same result with greater reliability and smaller equipment volumes. Peltier units can be cascaded to obtain higher levels of refrigeration.

For more information circle **57** on inquiry card.

Precision Micrometer has Swinging Anvil

Accurate testing and gaging of irregular components has long been a problem in defense and aircraft production. A new Swiss-made micrometer, designated the Polyplan micrometer, now incorporates replaceable anvils which swing to either side to permit ac-



curate measurement between two points not in the same axis. Each micrometer is also furnished with six different interchangeable anvils to facilitate the measurement of odd shapes and contours.

The flexibility afforded by the swinging anvil is also said to provide improved accessibility to parts while in process of machining, to permit measurement without their removal. Reading to 1/10,000", the micrometers are offered in 0-1", 0-2" and 0-3" sizes, and carry a full year's guarantee. Made by BZG of Geneva, Switzerland, they are available in the United States from their importers, the *Polyplan Company, 45 W. 81st St., New York 24, N. Y.*

For more information circle **58** on inquiry card.

Photo-Voltaic Readout Cells

Silicon Photo-Voltaic Readout Cells are now designed for applications requiring detection and power conversion of light energy passing through coded holes, or apertures. The flexibility with which these cells can be used frees the designer from previous limits and opens up new vistas.

The Photo-Voltaic Readout Cells convert light energy directly into electricity, with no need for external power supplies. These self-generating devices are characterized by an extremely long lifetime, negligible temperature dependency and a very short response time. They operate over a wide ambient range from −65° to 175°C.

Fig. 1 shows an enlarged section of a typical three-segment P-V Readout Cell Assembly. Each segment consists of a "P-N" junction semiconductor. Elemental silicon can be altered to become "N"-type silicon and "P"-type silicon. The former has an excess of electrons, and the latter a deficiency of electrons, as compared to intrinsic silicon. When "N"-type and "P"-type materials are fused together a "P-N" junction is created, and in the region of this junction, an electric field exists.

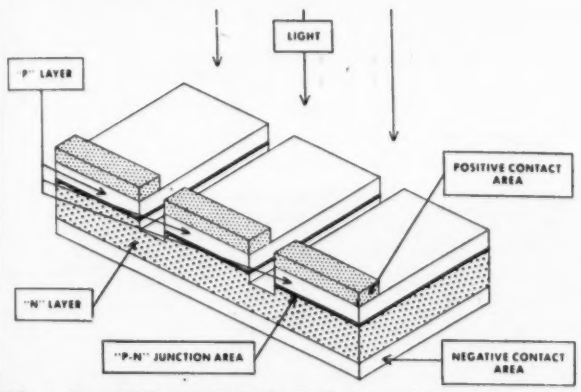


FIG. 1. PHOTO-VOLTAIC Cell Assembly of three segments.

When light energy photons strike a segment of the Photo-Voltaic Cell assembly, those photons that contain sufficient energy create a hole-electron pair within the silicon segment. The "built-in" electric field within the segment works on the hole-electron pair and causes a voltage difference between the "P" and "N" regions. When a load is connected across the output connections of the segment, this potential difference causes an electric current to flow.

The region between the segments contains no "P-N" junctions, hence isolation between segments results, allowing independent operation of each individual segment. Peak spectral response is at 8,500 angstroms, while the response time is 20 μsec or less, depending on resistance.

In some applications the output from the readout cell may operate the control device directly without amplification. If amplifiers are needed, transistor amplifiers are recommended because the low impedances of transistors are readily matched with those of the Photo-Voltaic Cell. (*From 4-page Technical Information Bulletin* 33-58, *Hoffman Electronics Corp., Semiconductor Div.*, 930 *Pitner Ave., Evanston, Ill.*)

For this literature circle **59** on inquiry card.

HIGH STRESS TUBE CAPS

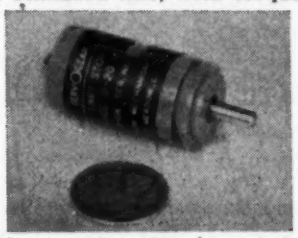
New tube cap connectors using silicone rubber compounds are said to

have temperature range from −70° to 500°F, high dielectric strength, and to prevent flashover at high altitudes. Glass-filled silicone type will withstand 1000°F for short periods, has high impact strength.—*Dept. TC*-133, *Alden Products Co., Brockton, Mass.*

For more information circle **108** on inquiry card.

MULTITURN LIMIT STOP

New LS subminiature stop is smallest of standard line, with torque rat-



ing of 18 oz-in. Can be set to any limit from 0 to 20 revolutions by external end screw. Meets MIL-E-5400. —*Precision Mechanisms Corp.*, 577 *Newbridge Ave., East Meadow, N. Y.*

For more information circle **109** on inquiry card.

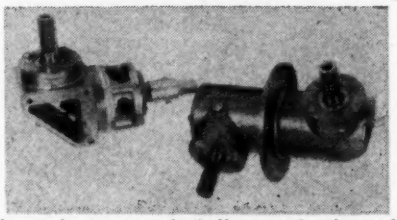
VOLTAGE LIMITER

New Model 66 Voltage limiter, continuously variable from 0 to 50 v dc is used to protect transistors and other devices from damage from overvoltage by providing output clamping and input removal to nominal 115v, 60 cps power source.—*Electronic Measurements Co., Inc., Eatontown, N. J.*

For more information circle **110** on inquiry card.

EMERGENCY FLAP OPERATOR

New right-angle gear control mechanisms meeting Military Standards provide manual operation of wing

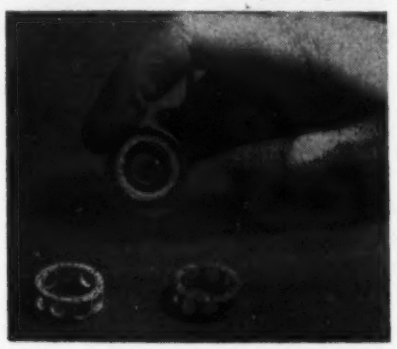


flaps in case of failure of aircraft hydraulic system. A 2,000 cycle operational test proved system 95.5% efficient, with an 243 in-lb input torque resulting in 232 in-lb output.—*Precision Gear Div., Perfecting Service Co., Charlotte 6, N. C., also West Coast Div., Los Angeles, Calif.*

For more information circle **111** on inquiry card.

LUBRICATING BEARING RETAINER

New Nysorb ball retainer for Gyro rotor bearings minimizes oil mass shifts by absorbing lubricant. Retainer is sintered from nylon powder



which is then impregnated with instrument oil under vacuum, retaining 20 to 25% of its own weight of oil even under 800 G acceleration. Bearing with oil-filled Nysorb retainer (right) operates for 25 times life of bearings with conventional phenolic retainers.—*The Barden Corp., Danbury, Conn.*

For more information circle **112** no inquiry card.

OXYGEN CYLINDER VALVE

New OV600 Oxygen Cylinder Valve for airborne gaseous oxygen bottles is positive acting and slow opening, has "O" rings for the spindle seal,

spindle of stainless steel, and seating on a Kel-F plastic seat, thus providing positive no-leak shut-off. A pressure gage indicates pressure in the oxygen bottle.—*Robbins Aviation, Inc.*, 2350 *East 38th St., Los Angeles* 58, *Calif.*

For more information circle **113** on inquiry card.

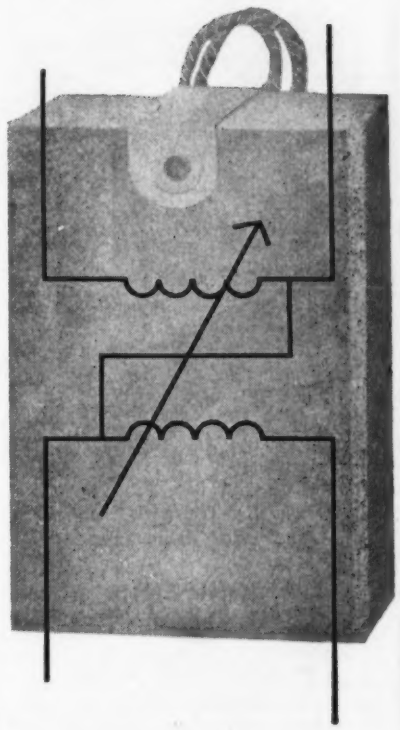
CAPTIVE PIN CONNECTOR

New Tamar 2075 Captive Pin Connector, USAF approved for use with RG-117/U cable, allows complete me-

chanical insertion of cable and good electrical contact prior to engaging threads. Available 100% tested for power and VSWR, to customer specifications.—*Tamar Electronics, Inc., Box* 1217, *Culver City, Calif.*

For more information circle **114** on inquiry card.

NO BRUSH PROBLEM



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For more information circle **32** on inquiry card.

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For more information circle **33** on inquiry card.

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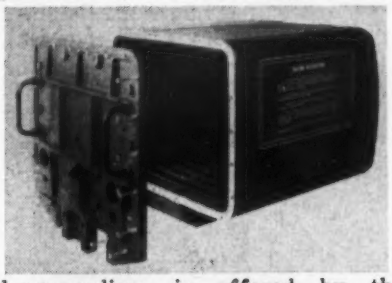


blower-cooling, is offered by the maker of the case illustrated which was fabricated for Navy guidance equipment. Submit specifications and prints to:—*Northeastern Engineering, Inc., P. O. Box* 150, *Manchester, N. H.*

For more information circle **115** on inquiry card.

CALIPER-SQUARE

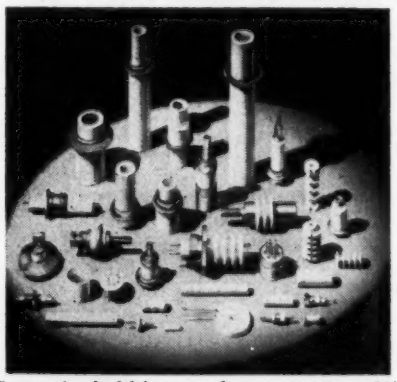
New Swiss Polyplan caliper-square with hinged lower jaw permits rapid

accurate measurement of two points on different axes, and measurement of plane and solid angles. Available in 10" and 7" lengths.—*Polyplan Co., 45 W. 81st St., New York* 24, *N. Y.*

For more information circle **116** on inquiry card.

CERAMICS FOR MILITARY SYSTEMS

AlSiMag technical ceramics for missiles, rockets and jet engines are used in ignition systems, controls electronic and telemetering systems.

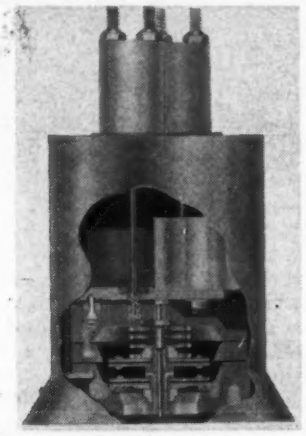


Ceramic bobbins and cores are efficient substrates for inductors and resistors. AlSiMag Aluminas combine with many metals to produce high-temperature metal-ceramic seals. Standard or custom designed applications are available. Send blue print with description of operating procedure for complete information on components for your application.—*American Lava Corp., Cherokee Blvd. & Mfgrs. Rd., Chattanooga* 5, *Tenn.*

For more information circle **117** on inquiry card.

HYDROGEN PEROXIDE VALVE

New Level Control valve designed for concentrated hydrogen peroxide provides efficient performance at al-

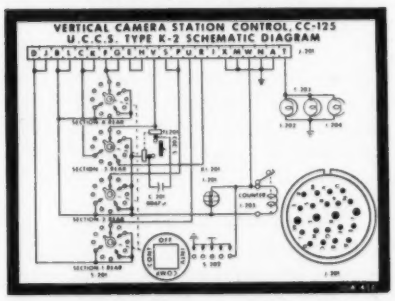


titudes to 60,000 ft and temperatures exceeding peroxide stability limits. Aluminum alloy and stainless steel construction, with 28 v dc solenoid actuation, accommodates 1½" fuel line.—*Aero Supply Mfg. Co., Inc., Corry, Penna.*

For more information circle **118** on inquiry card.

SCHEMATIC DIAGRAM SERVICE

Equipment diagrams on stainless steel, etched and enameled anodized aluminum and plastics; mount with

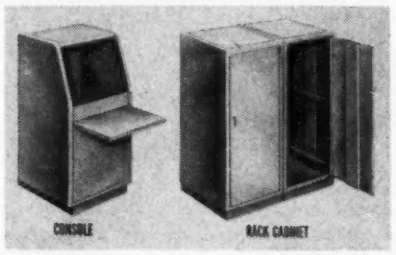


holes or adhesive backing. Masters can be made from copy supplied or redrawn for clarity, deliveries made within a week on emergency orders.—*Stafford Mfg. Co., Inc.,* 145 58*th St., Brooklyn, N. Y.*

For more infomration circle **119** on inquiry card.

STANDARDIZED ENCLOSURES

Cabinets, consoles and rack cabinets of steel, magnesium, aluminum, stainless and other metal alloys are



designed for modular applications so that units can be added and expanded when needed. Complying with Mil standards, they are fabricated on order to standard users specifications without additional cost.—*Falstrom Co., Passaic, N. J.*

For more information circle **120** on inquiry card.

Telemetry Transducer Converts Pressure to Frequency

Direct measurement of applied pressures in terms of frequency modulation is being applied in FM/FM telemetry in the aero-missile and commercial data-logging fields, and for automated production and process control where highly accurate, reliable data are required.

The Vibrotron Transducer (Fig. 1) applies the basic engineering principle of a vibrating wire to sense changes in pressure and provide a frequency signal output for direct readout as a numerical value.

A high degree of reliability is assured by the simplicity of the transducer design. A fine wire, stretched between an anchor point and a metal diaphragm, is set into vibration in a permanent magnetic field by an alternating current through the wire. This alternating current is supplied by an associated amplifier connected in an oscillator circuit such that the frequency of oscillation is controlled by the vibrating frequency of the stretched wire.

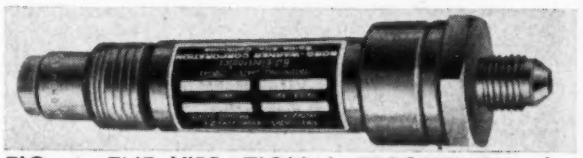


FIG. 1. THE VIBRATIONAL FREQUENCY of a wire under tension is the basic principle of the Vibrotron Pressure Transducer.

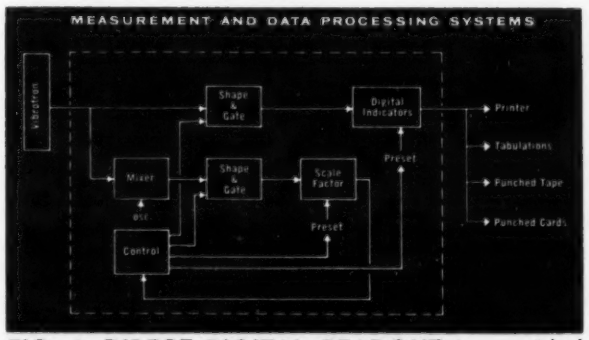


FIG. 2. DIRECT DIGITAL READOUT is provided by Vibrotron amplifier-transducer output.

The length and tension of the wire determine the frequency at which it vibrates. A change in pressure being sensed results in a slight displacement of the diaphragm which is instantly reflected as a change in the tension of the wire. Since a tension change decreases or increases the vibrating frequency of the wire, the transducer output frequency is proportional to the pressure applied; inversely, with respect to pressure, the frequency of the transducer output signal also changes.

Each Vibrotron amplifier, used with an associated transducer, comprises a stable, high-Q oscillator circuit, with the amplifier supplying feedback power to initiate and sustain transducer wire vibration, and amplifying transducer output signals to levels necessary for introduction into data-processing and logging systems.

Direct digital readout is provided by single and multi-point data processing systems designed for operation with the Vibrotron transducer. A simplified

diagram of such a system is illustrated in Fig. 2. Upon command, either automatic or manual, a read cycle is performed. The transducer output is coupled to the digital indicator counter by an electronic switch, which is opened by the read command; a second signal is also coupled to the scale factor counter. Simultaneously, the scale factor and the digital indicator are preset to numbers corresponding to the zero suppression and scale data entered on the front panel of the instrument. These presettings, together with the frequency mixing operation performed in the linearization, act to process the data for direct numerical readout in the digital indicator. When the scale factor counts to the zero position, the electronic switches close, completing the cycle. (*From 4-page Technical Bulletin* 58-130, *which also lists characteristics of Vibrotron transducer and amplifier units, BJ Electronics Div., Borg-Warner Corp., Santa Ana, Calif.*)

For this literature circle **60** on inquiry card.

Thermocouples for Use With Portable Potentiometers

When a portable potentiometer is to be used with thermocouples the "range of measurement" is usually the first consideration. The following table gives the ranges recommended for different type couples by Roeser and Wensel of the National Bureau of Standards:

Type of thermocouple	Temperatures Usual Range C°	Maximum C°
Platinum-rhodium	0 to 1450	1700
Chromel-Alumel	—200 to 1200	1350
Iron-constantan	—200 to 750	1000
Copper-constantan	—200 to 300	600

If the range is above 1200°C it is best to use platinum-rhodium couples. This type of couple is also used for calibrating other couples. It has a very low mv/degree change and requires a sensitive galvanometer.

Chromel-alumel is the best base-metal couple for high range, up to 1200°C, and can also be used to measure both high and low ranges if necessary. Its mv/degree output falls off considerably below 0° C, and its curve is also somewhat irregular.

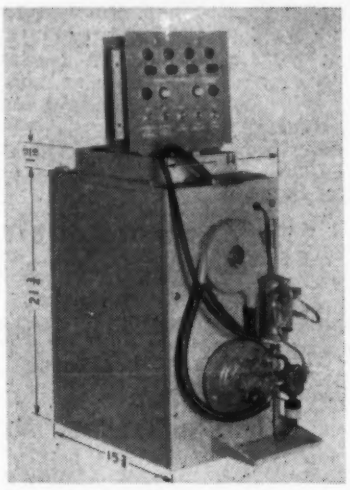
Iron-constantan has the advantage of having the highest mv/degree output, but also has the widest variations in its mv-temp curve. The recently revised NBS curve is now generally accepted. Iron-constantan mv-temp curves fall off quite a bit below 0°C, being only 0.02 mv/°C at —200°C.

Copper-constantan is generally recommended for close measurements in its range. While its mv/degree is lower than that of iron-constantan, it is generally more reproducible, and its mv/degree does not decrease below zero proportionately as much as the others. For this reason, it is nearly always used when temperatures to be measured are below zero.—(*From 4-page booklet, "Notes on Selection of a Portable Potentiometer," Gray Instrument Co.,* 200 *E. Church Lane, Philadelphia* 44, *Pa.*)

For this literature circle **61** on inquiry card.

NIKE CONTROL SPACE HEATER

Model DH-73 heater installed in ventilation control cabinet of Nike ground control trailer uses any grade of gasoline for fuel. 50,000 BTU out-

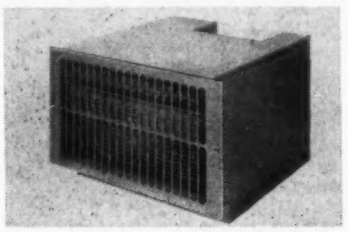


put from 2/3 gallon per hour of any grade gasoline is supplied by the heater to raise 500 CFM of air through 115°F. Starts from cold temperature of —56°F, requires 800 watts, 115 v 60 cps power while running, 400 watts while starting.—*Hunter Mfg. Co.,* 30545 *Aurora Rd., Solon, Ohio.*

For more information circle **121** on inquiry card.

RACK COOLER

New Model 1EB800G recessed centrifugal blower provides 1200 cfm

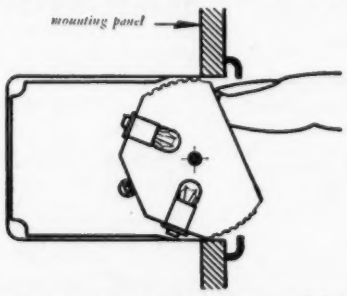


filtered air quietly to cool computers, control panels, telemetry cabinets, etc.—*McLean Engineering Labs., P. O. Box* 228, *Princeton, N. J.*

For more information circle **122** on inquiry card.

WORD INDICATOR LIGHT

New word indicator light, to indicate faults or functions of equipment,



provides flush mounting, rebulbing from front, removable legends, Mil. Spec qualification, and two-bulb safety factor.—*Master Specialties Co.* 956 *E.* 108*th St., Los Angeles* 59, *Calif.*

For more information circle **123** on inquiry card.

MSD new literature

CAPACITOR characteristics for complete line of Dur-Mica capacitors include full capacity vs. dimensions, capacity and voltage ranges tables, temp coefficient and capacitance drift tables.—Electro Motive Mfg. Co., Willimantic, Conn.

Circle **124** on inquiry card.

MICROWAVE Topwall short slot hybrid junctions for duplexing, diplexing and multiplexing are described and listed in 4-page short-form catalog HT58.—Microwave Development Lab., Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.

Circle **125** on inquiry card.

TIME DELAY RELAY with delay period adjustable from 30 millisec to 2 min is described in 4-page bulletin SM-2—AGA Div., Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth, N. J.

Circle **126** on inquiry card.

RF FILTERS for Waveguide and coaxial lines are listed with pass characteristic curves in 9 page catalog and supplement.—Microphase Corp., Box 1166, Greenwich, Conn.

Circle **127** on inquiry card.

HYDROELECTRIC SERVO VALVE featurning high reliability under missile environments is described in new 4-page bulletin.—Kearfott Co., 1500 Main Ave., Clifton, N. J.

Circle **128** on inquiry card.

MISSILE DYNAMOTORS, pressure transmitters and indicators, and aircraft type switches, autosyns, etc., are described in new 104-page collection of engineering bulletins.—Montrose Div., Bendix Aviation Corp., So. Montrose, Pa.

Circle **129** on inquiry card.

SPACE HEATERS for Military Shelters are described in new 6-page brochure, MH-162.—Hunter Mfg. Co., 30545 Aurora Rd., Solon, Ohio.

Circle **130** on inquiry card.

FLOWSOLDER METHOD for soldering printed circuits is described in new 36-page applications bulletin.—Electrovert, Inc., 124 E. 40th St., New York 17, N. Y.

Circle **131** on inquiry card.

FIXED FILM RESISTORS, commercial type are described in new 2-page engineering bulletin CF-1.—Mepco, Inc., Morristown, N. J.

Circle **132** on inquiry card.

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For more information circle **34** on inquiry card.

Vernier Pot Features Rapid Operation

Only three turns of the control knob cover the full range of the Type 81-A Rinco-Pot, a new 3-decade voltage divider using the Kelvin-Varley circuit (Fig. 1). A single control knob, using a unique and simple mechanical system, operates either of two resistance decades or the interpolating potentiometer (Fig. 2)

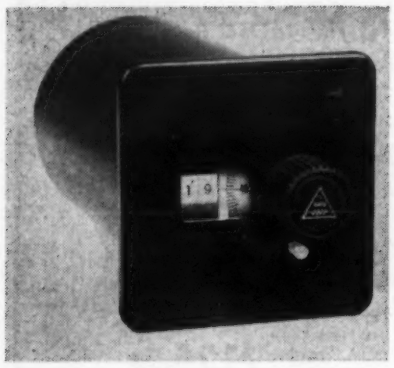

FIG. 1. PUSH-PULL knob mechanism gives speedy control of Precision Vernier Potentiometer. Dial reads to four places.

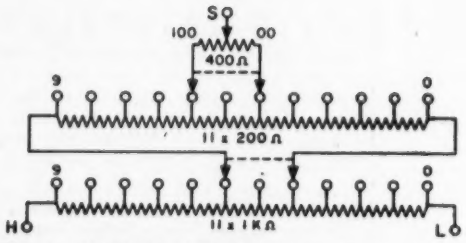

FIG. 2. KELVIN-VARLEY circuit is used to achieve high resolution.

with easy and positive drive. Simply push or pull the control knob and rotate it to the desired setting. Only three turns of the knob cover the full range, which compares to that of a 100-turn helical potentiometer or a 3-dial multi-dial potentiometer.

Easy-to-read dial registers directly to four places without parallax error. Complete unit mounts similar to a flush panel meter without dismantling. Dial lock insures against accidental changes in dial setting.

Recommended uses requiring a precision, high resolution, easy-to-use potentiometer or voltage divider are for analog computers, comparison standards, ratio bridges, slideback voltmeters, temperature potentiometers and linearity comparators. Standard range is 10,000 ohms; power rating, 5 watts; temperature coefficient, 0.002%/°C; linearity, ±0.01%; resolution, 0.002% or better. (*From Data sheet F159A, Rinco, Inc., 7962 S. E. Powell Blvd., Portland 6, Ore.*)

For this literature circle **62** on inquiry card.

FOR MORE INFORMATION ON ANY OF THE PRODUCTS REPORTED OR ADVERTISED IN THIS ISSUE, CIRCLE THE ITEM NUMBER ON THE INQUIRY CARD BOUND IN THIS ISSUE.

New Literature—CONT.

SERVO MOTORS, sizes 8 to 18 are specified in 12-page collection of engineering data sheets.—Servo Dynamics Corp., Somersworth, N. H.

Circle **133** on inquiry card.

X-BAND MICROWAVE Target Generator for radar system test is described in new 4-page bulletin MTG-100X.—Remanco, Inc., 128 Broadway, Santa Monica, Calif.

Circle **134** on inquiry card.

TRANSFORMERS and filter reactors for MIL-T-27A and commercial applications are described in new 32-page catalog.—Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill.

Circle **135** on inquiry card.

CIRCULARLY POLARIZED antenna feed system used in new ASR-2 Airport Surveillance Radar System is described in 4-page Report No. 3.—Eng. & Products Section, ITE Circuit Breaker Co., 601 E. Erie Ave., Philadelphia 34, Pa.

Circle **136** on inquiry card.

MICROWAVE COAXIAL Signal Samplers, Monitor Tees, DC Shorts and DC Blocks for sampling signals present in coaxial lines or removing dc or low frequency signals from RF signals in coaxial lines are listed in new 4-page technical catalog.—T. E. M. Inc., 71 Okner Pkwy., Livingston, N. J.

Circle **137** on inquiry card.

DIGITAL MAGNETIC TAPE INSTRUMENTS are described in new 4-page bulletins: Airborne Recorder, Type 5-702 in bulletin 1607; Type 5-680 Digital Recorder/Reproducer in bulletin 1608.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **138** on inquiry card.

PRESSURE PICKUP comprising twisted tube which rotates armature in variable reluctance bridge is described in 2-page data sheet.—Wiancko Engineering Co., 225 N. Halstead, Pasadena, Calif.

Circle **139** on inquiry card.

HIGH FREQUENCY PREAMPLIFIERS featuring low noise design in 100 to 250 mc range are described in new 4-page technical brochure.—A. R. & T. Electronics, Inc., Subsidiary of Baldwin Piano Co., P. O. Box 627, Little Rock, Ark.

Circle **140** on inquiry card.

SIZE 8 SYNCHRO motors and transistorized amplifiers are described with specifications and outline drawings in 4-page technical bulletin 501A.—Norden Division, United Aircraft Corp., Commack, L. I., N. Y.

Circle **141** on inquiry card.

SERVO MECHANISM in kit or assembled form adaptable to many military uses is described in new 4-page bulletin.—Servo Development Corp., 567 Main St., Westbury, N. Y.

Circle **142** on inquiry card.

MICROMINIATURE RELAYS are described in new tech data sheets: No. 700, current sensitive types, and No. 780, voltage sensitive types.—Electronics Div., Iron Fireman Mfg. Co., 2838 S.E. 9th Ave., Portland 2, Ore.

Circle **143** on inquiry card.

CUSTOM TUBING fabrications for missile, AEC, and aircraft use are described in new 4-page facilities brochure.—United Metal Fabricators, Inc., 3991 Jennings Rd., Cleveland, Ohio.

Circle **144** on inquiry card.

MINIATURE PRESSURE SWITCHES for military applications are described in new 28-page catalog.—Century Electronics & Instruments, Inc., 1333 N. Utica, Tulsa 10, Okla.

Circle **145** on inquiry card.

DRIVER AND OUTPUT TRANSISTOR transformers meeting MIL-T-27A specs are listed in new 4-page brochure.—Microtran Co., 145 E. Mineola Ave., Valley Stream, N. Y.

Circle **146** on inquiry card.

LOW DRIFT input silicon transistor ST1026 is described in new Silicon Transistor brochure TE-1353, Transistron Electronic Corp., Wakefield, Mass.

Circle **147** on inquiry card.

MAGNISTOR applications in digital computer and process applications are described in new 4-page brochure, "Reliability."—Magnistor Corporation, Potter Inst. Co., Inc., Plainview, N. Y.

Circle **148** on inquiry card.

FOUR-WIRE SYNCHROS for use as transmitters, differentials or control transformers are described in 2-page technical data sheet R982.—Kearfott Co., Inc., Little Falls, N. J.

Circle **149** on inquiry card.

TORQUE MOTOR, 6 oz unit which gives 5 lb stroke, is described in 1-page data bulletin No. 105.—Cadillac Gage Co., Costa Mesa, Calif.

Circle **150** on inquiry card.

MILITARY AND INSTRUMENT cases of deep drawn aluminum are described in new 12-page catalog. Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

Circle **151** on inquiry card.

SEMICONDUCTOR DIRECTORY lists about 1,000 transistors and diodes produced by 13 major manufacturers by part number, name of mfgr and OEM prices.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle **152** on inquiry card.

INSULATION STANDARDS publications list includes NEMA, AIEE, ASTM, and Military Specifications, in 16-page reference catalog No. 26 described by number, title, and specification.—Insulation Mfgr's Corp., 568 W. Washington Blvd., Chicago 6, Ill.

Circle **153** on inquiry card.

SCIENTIFIC BALANCES. 32-page Bulletin 6522 includes two-pan analytical; single-pan high-speed analytical; micro and semi-micro analytical; torsion; triple-beam; and special-purpose balances; weights and accessories.—Harshaw Scientific Div. of the Harshaw Chemical Co., 1945 East 97th St., Cleveland 6, Ohio

Circle **154** on inquiry card.

OVERHEAT PROTECTORS for aircraft electric motors are described in 4-page technical bulletins: MOPR-11D for 3-phase protectors, MOPR-2 for single-phase ac and dc motors.—Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.

Circle **155** on inquiry card.

CRYOGENIC, Nuclear, and High Pressure System engineering services and facilities are described in new 12-page illustrated facilities brochure.—Stearns-Roger Mfg. Co., P. O. Box 5370, Denver 17, Colo.

Circle **156** on inquiry card.

AIRVALVE FLANGE engineering drawing details for ten different types are shown in new data sheet F-8517.—Barber-Colman Co., Aircraft Controls Div., Rockford, Ill.

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FLUID CONTROLS for Missiles including valves and accessories for in-flight and ground support handling of oils, fuels, oxidizers and coolants are listed in new 4-page bulletin.—Koehler Aircraft Products Co., 409 Leo St., Dayton, Ohio.

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AIRBORNE INSTRUMENTS, Components, are described in catalog package of 13 engineering bulletins. Includes pressure and acceleration devices, mach-No. calibrators, etc.—Burton Mfg. Co., 2520 Colorado Ave., Santa Monica, Calif.

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AIRCRAFT VOR/ILS indicator Model 4087 for executive and transport aircraft is described in new 4-page brochure.—LearCal Div., Lear, Inc., 3171 S. Bundy Dr., Santa Monica, Calif.

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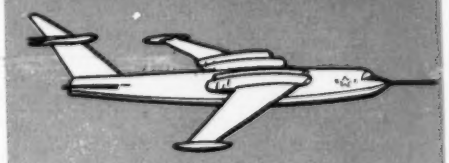

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arch 26—Fifteenth Annual Quality Control Clinic, Rochester Society for Quality ontrol, University of Rochester, N. Y. rite Earl D. Hogan, Eastman Kodak Co., odak Park Works, Eng. Div., Bldg. 23, ochester 4, N. Y.

arch 31-April 2—International Symposium on Millimeter Waves, Polytechnic stitute of Brooklyn, Microwave Research Institute, AFOSR, USRDL, ONR and IRE Engineering Societies Bldg., 79 W. 39th St., New York, N. Y. Closing date for submission of abstracts is Jan. 30, 1959. Write Prof. Herbert J. Carlin, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N. Y.

May 5-6—Interdisciplinary Conference on Self-Organizing Systems, Museum of Science and Industry, Chicago, Ill. Jointly sponsored by Armour Research Foundation and Office of Naval Research. Write Scott Cameron, Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

May 6-8—1959 Electronic Components Conference, IRE, EIA, AIEE and WCEMA, Benjamin Franklin Hotel, Philadelphia, Pa. Write Bernard F. Osbahr, Electronic Industries, Chestnut & 56th Sts., Philadelphia 39, Pa.

November 16-20, 1959—Fifth International Automation Exposition and Second Military Automation Exposition, The New York Trade Show Bldg., New York, N. Y. Write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.